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ELECTRICITY
A PRACTICAL TRADE JOURNAL

No. 1678.—Vol. XXXVII. FRIDAY, JANUARY 5, 1923. Price Twopence.

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CANNOCK U.D.C. ELECTRICITY SCHEME.

(*Concluded from page* 688.)

These oil switches (Fig. 3) have a maximum breaking capacity of 350,000 k.v.a., the total break per phase is 12 in., the head of oil about the contacts 11 in., the volume of oil 66 gallons. The control of the switches is by signal levers and suitable bell crank mechanism, which, together with the instrument panels, are shown in Fig. 4.

The construction of these switches throughout has been designed on very robust lines, the tanks being made of welded steel, strongly reinforced with angle-iron. These tanks are lined with 3-ply birch. This is a non-resinous wood, which is absolutely essential, as otherwise the resin gets upon the contacts of the switch and may prevent their opening.

The steel tanks fit into a deep recess in iron framework, which is securely bolted to the main cubicle structure. In this recess is fitted a thick gasket to prevent the emission of fumes. At the same time an ample vent pipe from the top of the tank to the air outside the building is provided to equalise the internal and external pressure at all times. In addition to the main securing bolts, further bolts are provided of sufficient length to support the tank clear of the contacts when the former is lowered for the inspection of the latter.

Great attention has been given in order to obtain a high speed of break of the contacts, a speed of 5 feet per second having been obtained. When opening under conditions of short circuit the magnetic blow-out effect of the current increases the speed of break above even this figure. The moving parts of the switch are naturally rather heavy, and an air dash-pot is provided so that no damage is caused by the switch movement being suddenly closed.

Some details of the G.E.C. biased system of protection (McColl patents), as applied to transformers, should also be mentioned. Protection against faults of any kind, including leaks to earth, between phases, and even between turns of the same phase, is effected by this system. The main underlying principle is based on a comparison of the currents that enter and leave the various windings; but by the special refinement introduced in accordance with the McColl patent, it is now possible to employ unusually sensitive settings for the relays, to avoid the danger of instability upon overloads that characterised earlier systems, and to remove the necessity for very exact, and therefore delicate and expensive, apparatus.

If all is in order in the transformer the entering and leaving currents are in constant proportion, the current ratio obviously being modified by a leak. Current transformers at either end of the windings supply proportionate currents to the relays, which open the circuit breakers when a derangement occurs.

The special feature of this system consists of restraining the actions of the relays by a coil excited in proportion to the load current. Thus the fault setting increases with the load, and can be safely made sufficiently sensitive to act in response to a small leak, without introducing the likelihood of improper tripping when a heavy overload increases all the currents in the circuits, and may easily swamp a moderate but constant setting. The importance of this is due to the fact that the great majority of transformer faults originate as small leaks between adjacent turns. Overload protection may also be afforded by the McColl relays, this practice being adopted in the case of the gear we are describing.

The 6,600 volt and 400 volt switchgear is enclosed in sheet steel cubicles, these are generally of a standard design, with interlocking arrangements to render it impossible for the isolating links to be opened until the oil switch is in the "off" position.

In addition to the sub-station at Queen Street, Cannock, a very important sub-station has been provided by the West Cannock Colliery Co. at their premises at Hednesford, to which the Council have already laid their mains. This is a very interesting sub-station, controlling, as it will do, the distribution of the supply throughout the colliery premises for different purposes. The Cannock Council have installed in this sub-station, in that part of it which has been allocated to them by the Colliery Co. by arrangement, very important switchgear, supplied and erected by Reyrolle and Co., Ltd., of Hebburn-on-Tyne, to the specifications of the Council's consulting engineers, whilst the Colliery Co. have, in turn, provided in their part of the sub-station somewhat

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similar switchgear as well as transformers for reducing the 6,600 volt supply to the pressure necessary for their own purposes, and all of which has been carried out to the designs and specifications of the Company's

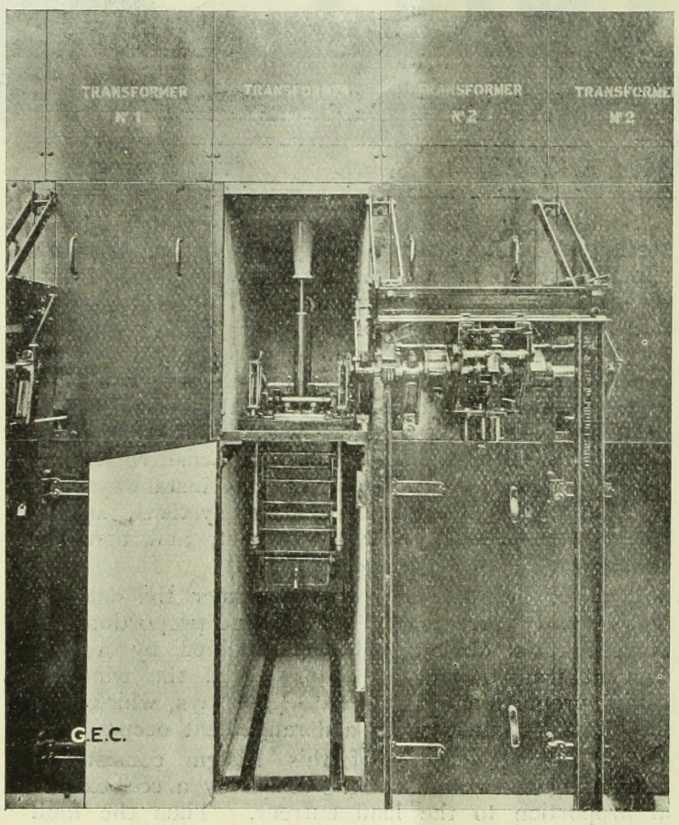


FIG. 3.

consulting engineers (Walter Dixon and Co., of Glasgow).

The main 6,600 volt cable, between the Council's sub-station at Queen Street and the sub-station at the colliery premises referred to, consists of 3 split conductors, each .10 sq. in. sectional area. This, again, is a paper insulated cable, lead-covered, wire-armoured and laid direct in the ground with suitable protection.

It is estimated that in the immediate future, at the West Cannock Colliery alone, there will be a demand of something like 800 k.v.a., whilst the requirements of the Cannock and Rugeley Colliery Co. will very substantially add to this demand, so that almost in its inception the undertaking from a supply point of view attains considerable importance.

The Council, as the local authority, have the advantage of a very substantial load, consequently a very substantial revenue, apart altogether from the supplies which they are giving to other consumers at Cannock, including public lighting. In addition to this it is anticipated that the Council will introduce the distribution of low pressure supply for private and public lighting, and other purposes, in other parts of their district, more particularly at Hednesford itself.

The demand for electricity for private lighting purposes has already been such as to justify the Council's decision to carry out a very important extension of mains along the New Penkridge Road, and there is no doubt that the undertaking will be developed in this way from time to time, so that eventually every part of their district will be served.

For the time being the Council intend to charge at the rate of 7d. per unit for lighting and 2d. per unit for heating on a flat rate system, but they also offer an alternative system under which consumers would be charged upon the basis of 15 per cent. per annum, payable quarterly, upon the rateable value of the property supplied, plus a charge of 2d. for each and every unit consumed. This particular system will enable consumers to make a greater use of the supply and with greater advantage to themselves for purposes other than lighting, such as heating, cooking and other domestic applications.

For hotels, shops, offices, etc., requiring supplies for lighting, heating, cooking and other purposes, the Council, in addition to the flat rate referred to above, offer as an alternative system the "maximum demand system," under which consumers would be charged at the rate of £2 10s. per quarter per kw. of maximum demand, plus 2d. per unit.

For ordinary power purposes the charge will be at the rate of £2 per quarter per kw. of maximum demand, plus 1d. per unit, subject to discounts varying from 5 per cent. up to 20 per cent., according to the demand made.

Special terms are granted to large consumers, such as collieries, engineering works, etc., which are the subject of special agreements.

The tariffs put forward by the Council are such as will enable them to supply electricity within their area



FIG. 4.

at rates at least equal to those prevailing in connection with a number of other electricity undertakings much larger than the Cannock undertaking.

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Further powers from the Electricity Commissioners, under a Special Order, are being applied for. Under these, if granted, they will be able to extend the use of their electricity undertaking over a much larger area, the proposed additional area of supply embracing such districts as Cheslyn Hay, Great Wyrley, Huntingdon, Penkridge, Hatherton, Brereton, Rugeley, and a small part of Brownhills.

The area of supply administered by the Cannock Council, as at present defined by their Order, has a length from east to west of about six miles, and a breadth from north to south of about three miles, but this, if the extension order is granted, will be increased in length to approximately 10 miles.

THE HIGH COST OF ELECTRICAL INSTALLATIONS.*

A representative gathering of contractors, salesmen, manufacturers' representatives and charge hands, etc., assembled in the library of the Institute, under the chairmanship of Mr. W. E. Highfield, M.I.E.E., to hear what has been, and unfortunately still is, a "thorn in the side" of everyone connected with the electrical world, concerning the expense incurred for an installation, no matter of what class (lighting, power and plant generally). It was with regret that owing to illness Mr. Revell was unable to be present, therefore Mr. Alldread was left to read the paper, and he dealt with the question under five headings :—A, B, C, D and E.

A.—Design of material and lay-out of the installation.
B.—Prices of manufactured materials and apparatus.
C.—Labour.
D.—Establishment or overhead charges.
E.—Contractors' profits.

The above headings are placed in order of their importance.

In dealing with A, the authors pointed out that all wiring systems have certain natural advantages, and that it was for the engineer or contractor to determine which particular system was best and most economical to use under the different circumstances which are met with from time to time.

The true test of the ability of an engineer was to be able to select the cheapest methods which would prove efficient and durable under the different conditions which are encountered, *e.g.*, where the wiring is exposed to heat and moisture the demands are very much more severe than those found in a private residence. Special designs of apparatus and accessories have a very great bearing on the ultimate cost of installation.

Simplicity is the chief ideal to aim for, but it was usually noticed that the present trend seemed to be the reverse. Comparisons were then dealt with by the lecturer showing the difference in a gas or an electrical installation. When gas, which is a very high explosive when mixed with air, and is a strong poison, is to be installed in a building, the work is usually considered too simple to require the services of an engineer, and is oftentimes given to the local ironmonger or gas company to carry out in the cheapest manner they think fit. Yet with an electrical installation (which from past records is proved to be very much safer, both from the point of view of fire and life), it is considered necessary to employ engineers to devise all sorts of safety arrangements and to apply very stringent rules with regard to the carrying out of the work. Designs of varying forms, mostly complicated, largely contribute to the cost of installation owing to the time necessary to connect same to cables, etc.

B.—PRICES OF MATERIALS AND APPARATUS.

It was noted by the authors that the greater portion of the manufacture of the materials, etc., vitally necessary to the electrical industry, is in the hands of powerful "rings" or "combines." Much doubt was expressed as to whether such "rings" or "combines" were necessary to the contracting industry, and instances were given of similar articles purchased from manufacturers outside the "rings" or "combines" which complied in every way to I.E.E. specifications and were 60 to 70 per cent. cheaper. Comparisons were shown with regard to electrical apparatus for export and those for home use, the price for the latter being far above the former, and yet the manufacturer made a fair profit on the export trade.

C.—LABOUR COSTS.

This item was regarded as the most speculative item in connection with the fitting-up of an installation. To the layman this would seem to be quite a simple matter, which is automatically determined by the rate of wages of the various grades of workers. Although the rates of wages directly affected the costs, it was not these that the successful contractor chiefly looked to to lower his costs, and that good organisation on an installation was a factor not to be disregarded. Tactful handling of men and an efficient foreman all helped to reduce the costs of labour by anything up to 50 per cent. or more.

D.—ESTABLISHMENT OR OVERHEAD CHARGES.

Under this heading details of expenses re rent, staff salaries, advertising, outlay on plant, tools, etc.

E.—CONTRACTORS' PROFITS.

Competition was a very important deciding factor in this direction, as to the margin that could be set aside under this heading.

Mr. Highfield thanked the lecturer for his very clear explanation of the high cost of electrical installations, and gave instances of his experiences in travelling abroad, where the towns had not passed through what he termed the "gas stage," but had gone straight on to electric lighting, etc. Many places in Northern France had electricity supplied for domestic purposes under a *yearly rental*, and could burn their lamps at all times and not on a unit consumption basis (£5 per annum, 11 points in house, 2s. per week).

In the discussion of the paper among the members present, many interesting views were given. Among those that spoke were Messrs. Smith, Kirk, Mills and Manning, and the blame for the high cost of installation was cast in many directions. Some speakers contended that the various supply companies' stringent regulations were to blame, and others that the inaccessibility of apparatus from the "connecting-up" point of view entailed unnecessary work. The meeting concluded with the usual vote of thanks to the lecturer and wishes for speedy recovery to health of Mr. Revell.

H. M.

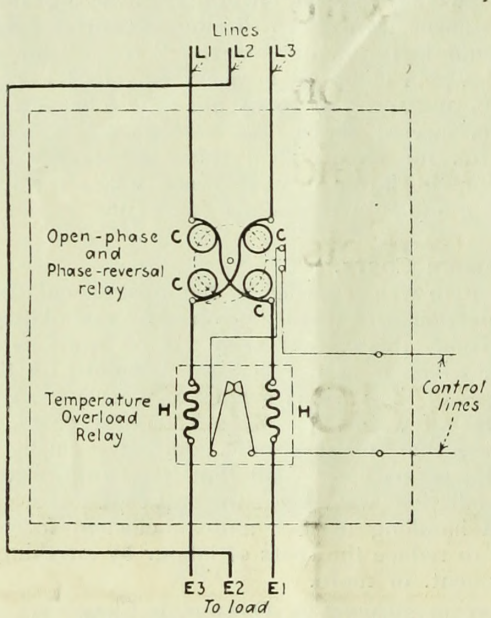
* Report of paper by Messrs. W. J. Revell and F. T. Alldread, read before the N.A.S.E., at St. Bride's Institute, on Tuesday, December 12, 1922.

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PHASE AND OVERLOAD PROTECTION FOR ALTERNATING CURRENT MOTORS.

Notwithstanding their very high reliability under all service conditions, alternating current motors require protection against excessive overload current (whether due to abnormal mechanical load or to electrical conditions), against open circuit in one phase conductor or winding (which would leave the motor to run as a single phase machine), and against reversal of phase sequence (which would cause the motor to run in reverse direction). The accompanying diagram, reproduced from *Power*, shows the connections and general principle of a novel double relay which gives complete protection against the three conditions stated above. The open phase and phase reversal relay consists of four electromagnets *C*, each with a pole shader over the core, connected diagonally, two in series in each of two supply phases. A copper disc is mounted in front of these poles and the effect of the arrangement is that the disc is subjected simultaneously to a single phase torque tending to turn it in a counter-clockwise direction and to a polyphase torque tending it to a clockwise direction. Under normal conditions, the clockwise torque is the greater and the disc is held stationary against a stop. In the event, however, of phase reversal or open phase, the disc turns in the counter-clockwise direction and, in so doing, opens a contact in the control circuit, thus stopping the motor.



The overload relay is a thermal device consisting of two heating coils *H*, one in each of two supply phases. These coils heat two thermostatic strips and in the event of sustained overload the strips bend and open a contact in the control circuit. In the actual apparatus the thermostatic strips simply trip latches which operate the contact, and it is possible to set the latches so that the device operates at anything from 80 to 120 per cent. of the rated current of the motor. The time lag in the operation of this overload device prevents the circuit being opened by momentary overloads and thus removes the temptation to the operator of "setting up" the overload device. It is claimed that the thermal relay never shuts down the motor unnecessarily, and should the operator set up the latch he can only do so to the extent of 20 per cent. above the motor rating.

AN OPPORTUNITY FOR STUDENTS.

We have great pleasure in calling the attention of our younger readers to the exceptional opportunity now offered to them by the Institute of Metals (36, Victoria Street, London, S.W.1). Anyone whose age is between 17 and 25 years, and who is either a student of metallurgy, or a pupil of or assistant to any person qualified for ordinary membership of the Institute (regardless of whether such person is actually a Member or not) may become a Student Member on the following terms:—The entrance fee is £1 1s., and the annual subscription £1 1s. (in both cases a fraction of the charge for ordinary membership). In return for these small payments the student enjoys all the privileges of full membership except as regards voting. He receives two bound volumes each year of the Journal of the Institute, and these alone are worth more than the annual subscription. Indeed, the Institute will actually lose money on its students until they enter the Member Class, which, be it noted, they may do without payment of any further entrance fee. The last election for students was on December 14, and we strongly advise readers to apply at once to the Secretary for the requisite forms, mentioning the name of this paper. This opportunity is one which no keen student or practical worker can afford to neglect. The value received is much greater than the expenditure involved.

A leaflet illustrating their range of cast-iron fittings for metal filament and gasfilled lamps has just been issued by the **Engineering and Lighting Equipment Co., Ltd.**, of Sphere Works, St. Albans. An important feature therein is the Anti-Vibrator Disc, which prevents vibration reaching the lamp filaments and helps materially to reduce lighting maintenance charges.

Cardiff Engineering Exhibition.—It is pleasant news to hear that the Engineering Exhibition which has just recently been held at the Drill Hall, Cardiff, was so successful that the time was extended until up to and including the 29th Nov. and this gives us an opportunity of making further reference to the exhibits of our friends the General Electric Co., whose Cardiff branch arranged a display of an extremely comprehensive nature, representing many sides of their vast manufacturing organisation. One of the main objects was to show colliery and steelworks engineers in the district the very latest electrical gear of the heavier type which is available, and modern designs of switchgear were particularly in evidence, including a 6,600 volt truck type cubicle, a large unit type switchboard which is being supplied to one of the local collieries, also an excellent example of an automatic push-button contactor panel, connected to the mains so that its operation might be demonstrated. The range of flame-proof switchgear covered every possible colliery requirement, a good deal of attention having been attracted by the Ironclad draw-out gear, of which a pillar was shown complete with measuring instruments, instrument transformer cases, cable boxes, etc., etc. There were likewise examples of the well-known "Witton" motors, colliery signalling apparatus, including the Peel-Connor mining telephone, the "Magnet" engine-room shaft, and the "P.D." relay, an entirely new device which operates with very low currents on both A.C. and D.C. circuits, and enables the bare wire system of haulage road signals to be retained. The G.E.C. were fully alive to the interest which domestic apparatus now creates amongst all classes, and in consequence had a special display of pedestal heaters, electric ovens, kettles, hot plates, grills, and so forth.

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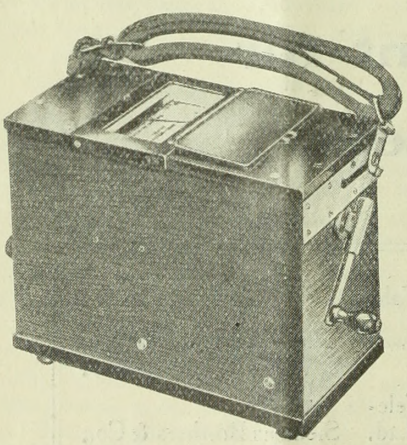
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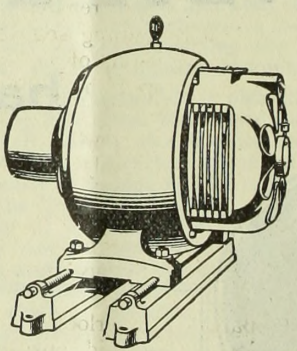
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TO OUR READERS.

ELECTRICITY is published every Friday, and, if ordered, is on sale at the principal Railway Station Bookstalls and Newsagents on that day. It has a very large sale throughout the United Kingdom, as well as in the British Colonies and Abroad.

Questions to which an answer is required must be accompanied by a 1½d. stamp for reply. When considered of sufficient interest, the answer will probably appear in the paper.

New advertisements for the displayed columns and alterations to existing ones must reach the publishing office not later than first post Tuesday morning, in order to be in time for the issue of the following Friday. This is important Rate quoted on application. Subscription: 13s. a year, 6s. 6d. half year, 3s. 3s. a quarter in advance, postage prepaid in the United Kingdom and abroad.

All remittances payable to the Publishers, S. RENTELL AND CO., LTD., 36-39, Maiden Lane, London, W.C.2. Telephone No. 2460 Gerrard.

Current Topics.

Won't You Sit Down?

The *Daily Mail* has opened up its correspondence column to a discussion on the apparently vexed question of decadent chivalry in public vehicles, such as tramcars, motor omnibuses, "tube" trains, etc. Certain interested members of the travelling public affect to see in the failure of many men to offer their seats to passengers of the opposite sex in a full compartment a regrettable decline in the courtesy which was the invariable accompaniment in similar circumstances of the Victorian era. Other critics take the view that the tendency of men to remain seated in a full vehicle is an inevitable outcome of the now recognised equality of the sexes, and argue with some degree of logic that woman, having fought so long for her rights, should be prepared to take the consequences and, like her male contemporary, face the ordeal of strap-hanging.

Although the controversy has lasted through several issues of the paper, and a leader has even been devoted to it, all the contributors to the discussion appear to have lost sight of the real reason why mankind is acquiring the habit of remaining seated in overcrowded public vehicles. The reason, of course, is that conveniences for public transport have not kept pace with the increasing population of our cities and towns. Culminating during the war, when vehicles were comparatively scarce and everybody was prepared to suffer some inconvenience, the habit has stuck, and the transport authorities, in the circumstances, see no particular reason why they should bother about altering conditions which the public apparently accept without protest.

Everybody apparently overlooks the fact that a ticket purchased, or a fare paid, entitles the passenger to a seat, whether it be in a tramcar, bus, or train. Admittedly, it would be a physical impossibility to allot seats to everyone who travels in London or our other big cities and towns to-day; but the fact remains that the public generally are entitled to seats if they only insist upon their rights. So long as they are content to travel *à la sardine*, so long will the transport authorities encourage them in so doing, for it means lessened traffic costs, fewer vehicles in commission for a given number of passengers, and, incidentally, bigger dividends. So by simple process of reasoning we arrive at the real cause of the apparent absence of latter-day chivalry. Men, and more especially working and business men, who perforce have to travel during the times when traffic congestion is at its height, find by experience that unless they ignore the appeal of a pretty face, they may, in fact, stand all day and every day, even when tired out with the day's labour, and never enjoy the physical comfort of a seat in a travelling vehicle at all. Much as I dislike seeing ladies strap-hang in any vehicle in which I happen to be travelling, I only relinquish my seat to the aged or to a mother burdened with children or parcels. The remedy is in the hands of the public; let them insist on better accommodation, and they will get it, but the appeal must be insistent, and, above all, general.

Broadcasting.

The new pastime has caught on, and the public have already had a foretaste of the possibilities of broadcasting, in the many excellent programmes transmitted during the Christmas holiday. The demand for receiving sets is insistent, and there are many to choose from, good, bad, and indifferent. It must not be overlooked by the purchaser of broadcasting apparatus that B.B.C. approval is by no means a guarantee of excellence, but purely and simply a certificate to the effect that the set which it adorns has passed the company and Postmaster-General's standards in regard to limited reaction, and other characteristics affecting the general comfort of listeners-in. Incidentally, there are some very poor examples of British workmanship being offered, as well as some highly-finished examples of the instrument maker's art.

In their anxiety to cater for a popular purse, some of the smaller makers must be in the business from philanthropic motives, judging by the prices at which their sets are being sold to the public; for, if one deducts the usual discounts to the trade, patent royalties, Broadcasting Company's commission, and other incidentals, there is not much evidence of bread and butter, or even bread and margarine for the actual manufacturer. However, things will straighten out in due time, and when the public have acquired experience they will begin to buy on efficiency, rather than on pure £ s. d., and it is on this basis that the broadcasting industry will stabilise. The present is the time of the opportunist, and he is making hay while the sun shines. It behoves the trade buyer to rely on reputable firms for his supplies, or he will ultimately find himself landed with unsaleable stocks of wireless junk.

While on this subject I wonder how the present holders of experimental licences will regard the new formulæ that would-be experimenters are called upon to resolve. The present-day applicant for an experimental licence is required to fill in an ominous blue form which seeks as much and as various information regarding his past, present, and future history, private concerns, origin, and other factors, as the most complicated application for life insurance. I used to regard the Income Tax Schedule and some of the war-time documents which one had to fill in as the giddy limit; but we have apparently not yet reached the zenith of official inquisitiveness, if one may judge from Form A issued under the Wireless Telegraphy Act. When one takes into account the invaluable research work which

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has been accomplished in the past by wireless amateurs and remembers how backward this country was in wireless development at the outbreak of war, one marvels at the apparent discouragement offered to further efforts, as evidence this very abstruse document dealing with what is really a very simple proposition.

Acoustics.

Judging by experiences in the development of perfect wireless telephonic transmission, the design of appropriate loud-speaking receivers, and the influence of apartment interiors on both transmitted and received sounds, it would appear that the neglected science of acoustics is at last coming into its own. Already a correspondent in the *Architect and Builders' Journal* is appealing for the organisation of Acoustical Research, mainly in connection with the design of building interiors, and it would appear that the problems which are presenting themselves to the promoters of broadcasting might also afford such an organised body abundant food for investigation. As matters stand at present, I incline to the opinion that the possibilities of broadcast reception are limited in scope. I have listened-in at many private installations, as well as to public demonstrations, and in every instance the former has been successful, whereas the latter has been a wash-out, even where the conditions have been similar in detail.

It would appear that the present limitations of the loud-speaking receiver in regard to volume and clarity of reception destroy those necessary characteristics whenever efforts are made, either by extra amplification or the use of two or more loud speakers, to fill a large hall, and render the reception audible to a large number of people. Visitors to the Horticultural Hall will remember the unnatural tones of the very much magnified reception there whilst other readers who have attended similar public demonstrations on a lesser scale will have had the same experience. In a private house, even given a fairly large room, on the other hand, the most perfect and clear reception is given, without any of the resonance of distressing "horn" effect, which is so much in evidence with much amplification. Our wireless experts will have to devote a share of their attention to acoustics which, as I remember it, is a very fascinating study.

Bravo, Douglas.

At last this famous Isle of Man holiday resort is to have a municipal Electric Power Station of its own. The foundation stone was well and truly laid the other day, and optimists predict an initial supply by Whitsun, in time for the early holiday makers, so that apartment houses will soon be in the throes of wiring, and Manx contractors look like enjoying a prosperous season. I wish the town joy of its imminent electric light; but there is one thing I sincerely hope the Corporation will never assent to, at least in my time, and that is electric trams. An electric tramway system along Douglas promenade would ruin it from a holiday maker's standpoint. The present toast-rack horse-cars are a restful change from the clang and jangle of the high-speed electric and add to the charm of this attractive resort.

More Breakdowns.

Failures in electricity supply have been surprisingly frequent during the past month. Among the places affected are Bristol, Preston, Rhondda Valley, Hull, Surbiton, Chester, Worthing, Dover, Lambeth, Charing Cross, Bedworth, Whitby, and Walton. In many instances the interruption occurred during the busy Christmas shopping periods and caused much inconvenience. It behoves the responsible authorities to exercise every precaution against a recurrence, as the dependability of electricity is one of its greatest assets.

Caught in the Act.

That electrical veteran, Mr. A. P. Lundberg, has just recently been caught in the act of studying a treatise on "How to obtain longevity." In view of the fact that Mr. Lundberg will be 92 next March, and what is more he still retains very fair health, it really looks as if he had solved the problem and could quite possibly give the author points. I am certain that all my readers will join with me in wishing Mr. Lundberg further healthy, happy years and to see our industry make yet greater strides. As "the" switching experts of the kingdom he and his sons have had a big share in building it up. ELEKTRON.

BALL AND ROLLER BEARINGS.

"The Development of Ball and Roller Bearings" formed the subject of a lecture delivered by Mr. A. W. Macaulay to the members of the Junior Inst. of Engineers on the 10th ult. The lecturer commenced by referring to the recent contributions of Messrs. Palmgren and Heathcote, and offered tentative suggestions for commercial tests—the practical outcome of such theoretical researches—as being the main object of the lecture. After briefly describing the progress of development and design of both types of bearings during the past twenty years, Mr. Macaulay passed on to discuss ball and track conformity, the considerations underlying load-carrying capacity, margin of safety, and as a basis of commercial running tests the introduction of overload conditions so that such tests may be completed in reasonable time, some very useful data being given in this latter connection. Attention was also directed to ball and roller bearings in service, maintenance, limits and applications to marine, crane, rolling stock, railway and other work, both from the commercial and technical aspects.

Four principal suggestions for the conditions under which the commercial tests should be carried out were:—(1) To submit the bearing to 100 hours continuous running under pure radial load at 1,000 r.p.m. with the intention of subjecting the balls and races to such a number of revolutions in a reasonable time as will just produce flaking from excessive fatigue, the result to be the average obtained from at least half a dozen bearings; (2) the test load to be twice the listed capacity; (3) the probable life under other loading to be derived from the cubic law, *i.e.*, the life at normal listed load (half test load) would be 800 hours, and so on; (4) these severe conditions representing an admission of a definite life to a bearing must be considered in relation to the majority of applications in actual service.

Many practical points were brought forward in the ensuing discussion, whilst the consensus of opinion appeared to indicate that the proposed tests were not any too severe.

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Questions and Answers by Practical Men.

RULES.

QUESTIONS: *We invite our readers to send us questions, preferably on technical problems that have arisen in actual practice. Questions which we consider of sufficient interest to our readers will either be replied to under "Answers to Correspondents" or replies will be invited from our readers. One shilling will be paid for the question which we select for competitive replies in this column.*

ANSWERS: *A fee of 10s. will be paid for the answer which we consider shows the greatest merit, and 5s. for the one we select as second best. In judging the replies, importance will be attached to clearness and conciseness, as well as accuracy. The Editor reserves the right to make no award, or to accept only one reply, if, in his opinion, the answers received do not possess sufficient merit. Competitors desiring the return of their manuscripts, if unaccepted, should enclose stamped addressed envelope.*

Write on one side of the paper only, and if diagrams are sent, draw them on a separate sheet of paper attached to the manuscript. Competitors may adopt a "nom de plume," but, both in the case of questions and answers, the competitor's real name and address must be sent with the manuscript as a guarantee of good faith. No correspondence will be entered into with regard to successful replies. The Editor's decision is final.

Commencing with Question No. 101, a Diploma of Merit will be awarded to the six competitors who win the first or second prize the most times during the next twelve months.

The words "Questions and Answers" or "Q" and "A" should be placed at the top left-hand corner of all letters intended for this column.

Answers to Questions.

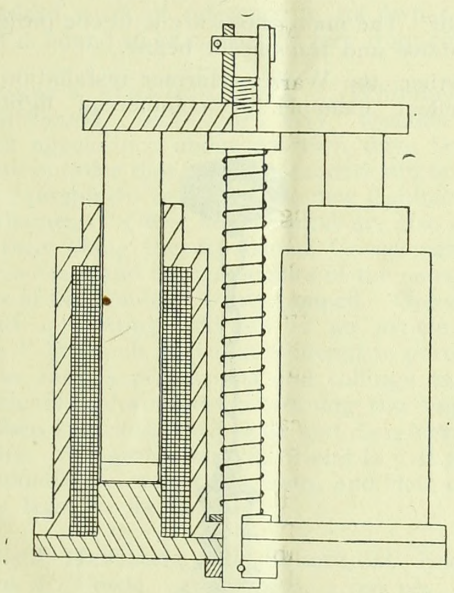
QUESTION NO. 151.

Can any reader inform me of an easy method and means of calculating the details necessary to design a magnetic brake of the solenoid type, such as is used on electric cranes?—"A. A. M."

REPLIES TO QUESTION NO. 151.

The first prize (10s.) has been awarded to "M. M." for the following reply:—

A suitable design for the required solenoid is illustrated in the accompanying drawing. Two solenoids are suggested, with a spring to ensure a quick release.



The cores slide in brass bushes with a disc of soft copper below the plungers to prevent any trouble from jarring.

The following will be found a simple and convenient method by which the dimensions and winding may be calculated.

To find area of plungers:

$$A = \frac{P \times 72{,}200{,}000}{B^2}$$

where A = area in square inches.
P = pull in pounds.
B = density of lines per sq. inch.

It is generally more satisfactory to have small stroke.

Suppose we want a pull of 60 lb.; then, allowing 20 lb. for the spring, each core must give a pull of 40 lb. Let the gap be $\frac{1}{2}$ in. With a density of 50,000 lines per sq. inch, and taking leakage as 30 per cent., the density in the air gap will be

$$\frac{70}{100} \times \frac{50{,}000}{1} = 35{,}000 \text{ per sq. inch,}$$

$$\text{then area of core} = \frac{40 \times 72{,}200{,}000}{35 \times 35} = 2.357 \text{ sq. inches.}$$

$$\therefore \text{ diameter} = \sqrt{\frac{2.357}{.7854}} = 1.73 \text{ (say, 1.75 inches).}$$

$$\text{Ampere turns} = .3133\ Bl.$$

(where l = length of air gap).

$$\therefore \text{ Ampere turns} = .3133 \times 35{,}000 \times .5 = 5483.$$

In the winding space we can have 14 layers of 120 turns each = 1,680 turns of No. 20 d.c.c. copper wire. With the two in series the cold resistance of this winding will be about 17.5 ohms.

We want 5,884 ampere turns,

$$\therefore \text{ current} = \frac{5{,}884}{1{,}680} = 3.5 \text{ amps. (approx.)}$$

For this current an external resistance, on a 110-volt circuit, will be

$$\left(\frac{110}{3.5}\right) - 17.5 = 14 \text{ ohms. (approx.)}$$

The above will show the method of design; alterations can be made in dimensions and winding to suit circumstances. Holes could be drilled in the iron covers to secure ventilation.—"M. M."

No second award is made.

The Electro-Harmonic Society.—The next Smoking Concert will be held in the Caxton Hall, Westminster, on Wednesday, 10th inst., at 8 p.m.

Finance.—An interim dividend at the rate of 7 per cent. per annum will be paid on the preference shares of Crompton and Co., Ltd., for the six months ended September 30, 1922.

Well Merited.—Congratulations to Sir Edward Manville, M.P., on the knighthood which has just been conferred upon him. During his strenuous life he has had much to do with the growth of the electrical industry, and we feel proud, therefore, that his services to his country have at length been acknowledged and rewarded.

The **B.T.-H. Co., Ltd.**, of Mazda House, are making a special push with their new fittings for office lighting. They are carefully designed to eliminate eyestrain, and at the same time to give the most comfortable illumination, and we understand that they are meeting with great favour in the business world.

We have received from **Messrs. Sir Isaac Pitman and Sons, Ltd.**, the well-known technical publishers, of Parker Street, London, W.C. 2, a copy of their new catalogue of scientific and technical works. It is very comprehensive and contains details of a large number of books which will interest the readers of this paper, so we can cordially recommend early application for a copy of the new list.

Messrs. Higgs Bros., the well-known motor specialists, of Sand Pits, Birmingham, are now extending to a period of two years their guarantee of the motors which they manufacture. This is, we believe, a very uncommon thing as regards electric motors, and it speaks volumes for the confidence which the firm have in the quality of their own goods.

List S.40, dealing with switch and plug connector combinations, has just been published by **Messrs A. P. Lundberg & Sons**, the well-known "Lektrik" specialists of 489, Liverpool Road, London, N.7. It deals with a large number of the special combinations of switches and plugs for which this firm has built up such a reputation during its forty years of existence, and it is certain to prove of direct interest and business value to installation contractors, to whom it will willingly be sent on application.

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WINDOW DISPLAY COLOUR LIGHTING.

By means of the B.T.-H. "X-Colour-Ray" attachment, which, both in design and construction, is the essence of simplicity, consisting as it does of only frame, slide and colour medium, the striking window display lighting is made economically possible. In practice the frame fits over a "Jove" or "Jupiter" X-ray reflector, and is attached to the reflector by means of four hooks, which fix in the ventilation holes. The slide is made to hold the gelatine colour medium (the only medium that does not rapidly fade), supporting it by means of fine steel wires. Red, amber, blue and green are the standard colours provided, and the insertion or withdrawal of the slides is the work of a moment. An important feature is that the colour of the lighting can be changed in a few seconds by the substitution of one slide for another. Thus, by keeping a few spare slides, the trader is able to alter the appearance of his display as often as he likes.

One of the latest and most effective installations of "X-Colour-Ray" lighting is in the windows of Wallace-Harmer Motors, Limited, Kingsway. The special points in the display. These projectors serve to emphasise the high-lights on the coach and metal work, and as they are fitted with slides of a different colour from the main lighting, the effect is very attractive.

The lighting of the showroom itself is effected by means of the B.T.-H. "Keldon" fittings—a unit which has particular advantages for this class of service. It is a semi-indirect fitting, but differs from the ordinary bowl fitting in being totally enclosed, and therefore dust-proof. The main glassware is in one piece, transparent above and translucent below.

Altogether, the Wallace-Harmer installation affords an excellent example of commercial lighting on thoroughly modern lines. Further information on this subject may be obtained from the Illuminating Engineer's Department of the British Thomson-Houston Company, Limited, at 77, Upper Thames Street, E.C.4.

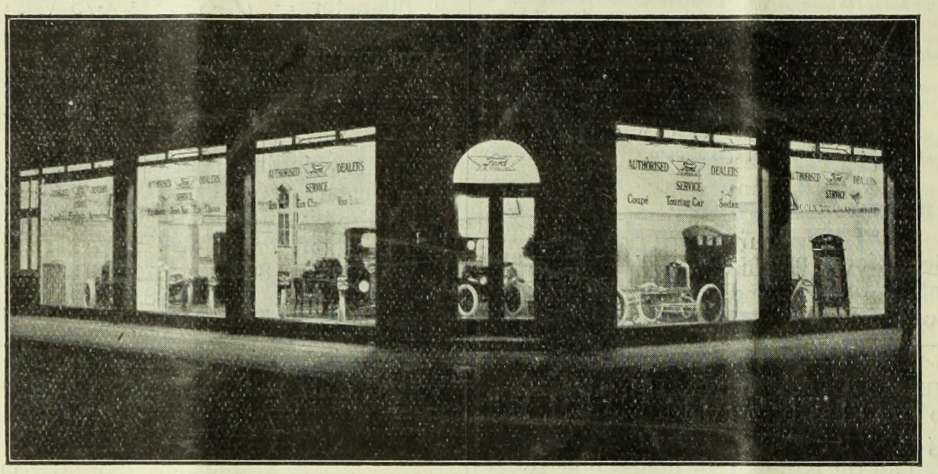


FIG. 1.—WINDOWS OF WALLACE-HARMER MOTORS, LTD., KINGSWAY.

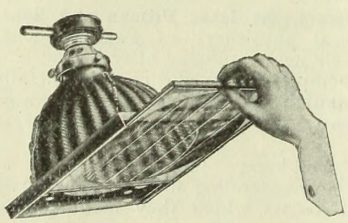


FIG. 2.—X-RAY REFLECTOR WITH COLOUR ATTACHMENT.

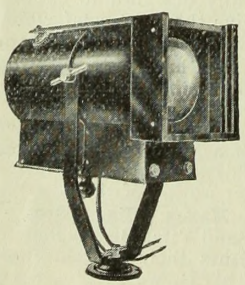


FIG. 3.—B.T.-H. SPOTLIGHT PROJECTOR.

X-ray reflectors, equipped with Mazda gasfilled lamps and fitted with colour attachments, are fixed at the top of the window behind the fascia, and in addition B.T.-H. spotlight projectors, also fitted with colour slides, are used to concentrate light on one or more

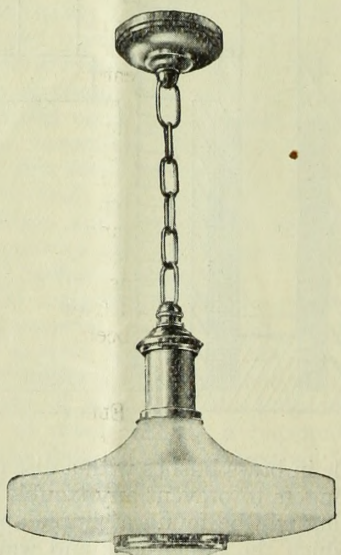


FIG. 4.—"KELDON" TOTALLY ENCLOSED, DUSTPROOF FITTING. AS USED FOR INTERIOR LIGHTING OF WALLACE-HARMER MOTORS, LTD.

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Reviews of Books, &c.

[Books noticed in this column will be sent from ELECTRICITY *Office to any part of the world, for the published price, plus ten per cent. for postage (minimum 2d.) and orders will be appreciated.]*

THE LAW RELATING TO ELECTRICAL ENERGY IN INDIA. By J. W. Meares. 2nd edition. Cl. 8vo, 381 pp. (Thacker, 24s. net.).—This is the second edition of what was practically an explanatory résumé of the Indian Electricity Act of 1910, and much credit is due to the author, Mr. J. W. Meares, for the careful manner in which the new edition has been brought up to date, so as to incorporate the changes which have been made by the amending acts which were passed in 1914, 1920 and 1922. It gives in a concise and clearly understood form all the legal details which govern the supply of electrical energy throughout our Indian Empire, and as such it should prove an invaluable work of reference to all the big electrical engineering firms in this country who lay themselves out to supply plant or carry out electrical undertakings in India. We have therefore no doubt that it will find a ready sale among such clients, and that it will prove its use to them in nearly every estimate which they may have to prepare and submit for work in that country. The printing and productions are in every respect first-class, and the author is able to write on the subject with a familiarity and authority possessed by no one else in India. As the standard work of reference in its own particular sphere it is bound to be consulted very frequently.

WHITAKER'S ALMANACK, 1923. (Whitaker, paper, 3s., half-bound, 6s.)—Our ever welcome friend made its appearance about fourteen days before the usual date in order that its many readers might have an early and prominent record of the new Cabinet and the new Parliament. Other new features are also included, among them being the provisional Government of the Irish Free State and full particulars of the newly-elected members of the London County Council. One decidedly new and interesting addition is an article entitled "Career," in which advice is tendered to parents with regard to various professions and callings as well as much valuable information concerning the steps to be taken when launching their sons and daughters on the sea of life. Altogether our old friend is just as useful and invaluable as ever it has been, and that is saying the very least in its favour.

STANDARD HANDBOOK FOR ELECTRICAL ENGINEERS. By Frank F. Fowle. 5th edition, 2,100 pp., profusly illustrated. (McGraw-Hill, 30s. net).—This is one of those monumental textbooks which may be said to represent the alpha and omega of a science, and as electricity has grown from lusty infancy to what might be termed elephantine corpulency, so also has this fifth edition developed into a book 2½ inches thick and chock full of valuable information, tables and data. True the book is American, but much of the text applies to practice which is common to all countries, and as English engineers have to design, construct and control electrical installations in all parts of the civilised—and uncivilised—globe, they are always keen on keeping themselves in touch with the best practice of all countries so as to submit plans and estimates which are directly appropriate to the scheme under consideration. That is why this Standard Handbook has gained and held such a wide sale in Great Britain, and this new edition has been anxiously awaited by quite a number of clients. Each section therein has been most thoroughly revised by substituting up-to-date material and data for that which had lost its value in the march of progress, and where necessary additional matter has been included. It may therefore be taken without hesitation that the book is as reliable and accurate as it is humanly possible to make it, and we can most cordially recommend it to our readers.

NEW BOOKS PUBLISHED.

"Second Annual Report of the Electricity Commissioners," 108 pp., sewn, 2s. 6d. net.

"Electrical Engineer's Year Book, 1923," quarto, over 500 pp., 21s. net.

Correspondence.

To the Editor of ELECTRICITY.

SIR,—When reading "Elektron's" remarks in your issue of December 22, respecting imitations of electrical methods by the gas industry, one is reminded of the attempt to introduce a flexible gas pendant, in imitation of the ordinary adjustable counterweight fitting so commonly employed in electric lighting.

One wonders, also, what became of the switch which provided for gas control at a distance. It is still seen, occasionally, at trade exhibitions, but its installation appears to be more the exception than the rule.

If so far comparative failure results from the attempt to imitate control of electric lamps at a distance, one feels that it will be quite a long while, if it ever be possible, for gas switches to allow control of the lighting from two or more points, or provide for any of the other numerous convenient controls now available for electric lighting, which, to-day, are taken too much as a matter of course, instead of being boomed as one of the chief advantages electricity, as a lighting medium, has to offer over gas, and a deciding factor with a client who has both methods under consideration.

If the great advantage of control from two or more positions, for example, had been for the past 30 years or so with gas, we should, to-day, have found the British Commercial Gas Association making the most of it, to the detriment of electric supply, and have had to combat a telling argument in favour of gas.

The commercial manager of the Gas Light and Coke Co., Ltd., some time ago, publicly acknowledged that electricity had the lead of gas as regards convenience of control.

There is no doubt but that, as an industry, we dislike beating the big drum, and appear to prefer to hide our light under the proverbial bushel.

Convenience in control, with resultant economy, is not always first suggested by the contractor, and the advantages, when first mentioned by the client, are sometimes only grudgingly acknowledged.

An installation provided with a talking point for the client to elaborate among his friends becomes a free advertisement for the contractor responsible for it.

We are, Sir, Yours faithfully,

A. P. LUNDBERG AND SONS.

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Various Items.

China.—The present low exchange value of the mark has, unfortunately, enabled some well-known German firms recently to secure some important contracts for electric power plant and telephone equipments, at prices 30 to 50 per cent. below those quoted by British and American firms. On the other hand, certain difficulties in regard to the cost of materials and labour conditions may render the contracts more liable to show a loss than a profit.

South Australia.—An important electric power scheme is contemplated by the Commonwealth Power and General Electric Co., on behalf of which a representative (Mr. C. M. McLeod) has been making inquiries in Adelaide to discover which is the most suitable of the State's brown coal deposits for the production of power. The company is somewhat favourable to Moorlands as being the best, provided the deposits continue over a satisfactory area. The State Government have promised the concern whatever assistance is possible.

Tenders Invited.—The Southland (New Zealand) Electric Power Board invite tenders for the supply, delivery c.i.f. duty paid Bluff, and erection of outdoor transformer station equipment for the Monowai Hydro-Electric Development Scheme.——The State Electricity Supply Works of Montevideo invite tenders for 16,000 metres of coloured cords for internal wiring, and for 27,750 metres of 225-volt V.I.R. lead-covered cable. Further particulars of the above three tenders from D.O.T., 35, Old Queen Street, London, S.W. 1.

The Empire Exhibition.—We have received No. 1 of the *Empire Exhibition News*, which will be published at intervals, price 2d., from the office at 16, Grosvenor Gardens, London, S.W. 1. It contains illustrated articles dealing with various sections of this great imperial undertaking, and should help to further the aim which it has in view—viz., to make known to all his Majesty's subjects the vast resources of the Empire, and thereby foster and develop that great inter-imperial trade which is so essential for the life and well-being of the hundreds of millions who live in security under the British flag. From our point of view it can be stated that it will constitute the most up-to-date and representative assembly of machinery of all descriptions that the world has ever seen.

Melbourne Telephone Service.—According to a recent issue of *The Industrial Australian*, more than 1,200 people are awaiting connection with the Melbourne Central Telephone Exchange, and every effort is being made by the department to deal with the position. When the Collingwood automatic exchange was opened recently 550 lines were taken from the Central Telephone Exchange and added to the new exchange. It is anticipated that the 550 vacancies on the central exchange list will not be filled until the end of January. As for the remainder of the 1,200 on the waiting list, it seems almost certain that they will have to wait for twelve or eighteen months, by which time it is anticipated the new North Melbourne Exchange will be constructed.

Meetings.—The next meeting of the National Association of Supervising Electricians will be held on Tuesday, January 9, at the St. Bride's Institute, Ludgate Circus, E.C.4, at 6.45 p.m. Paper: "Electric Lifts," by H. Marryat, Esq., M.I.E.E., etc.——A meeting of the Illuminating Eng. Society will be held at the Royal Society of Arts (John Street, Adelphi, London), at 8 p.m., on Tuesday, 16th inst., when a discussion on "The Need for Suitable Training in Illuminating Engineering" will be opened by Mr. C. E. Greenslade and Mr. J. E. S. White.——The Scottish Centre of the I.E.E. will meet at the North British Station Hotel, Edinburgh, on Tuesday, 9th inst., at 7 p.m. Paper: "Domestic Load Building," by W. A. Gillott.——A Wireless Section Meeting of the I.E.E. will be held on Wednesday, 10th inst., at 6 p.m. Paper, "Design of Radio Towers and Masts: Wind Pressure Assumptions," by C. F. Elwell (Member).——The Junior Inst. of Engineers will meet at 39, Victoria Street, Westminster, S.W.1, on Friday, 5th inst. Lecturette, "Wave Power Transmission," by D. W. Dinwoodie (slides). Also on Friday, 12th, paper, "Transient Phenomens Arising in Transformers from Switching Operations," by S. A. Stigent (Member). And on Friday, 19th, lecturette, "Paraffin as Fuel for Marine Motors," by Stratford C. Saunders (Member) (slides). All at 7.30 p.m.——At the next meeting of the Inst. C.E., to be held on Tuesday, 9th inst., at 6 p.m., at Great George Street, Westminster, S.W. 1, the paper to be submitted for discussion is:—"Twelve Years' Operation of Electric Traction on the London, Brighton and South Coast Railway," by H. W. H. Richards.

West of Scotland Electricity District.—The Electricity Commissioners have extended the time within which objections or representations may be made, or any improvement scheme may be submitted, until June 30, 1923.

Argentina.—According to the *Board of Trade Journal*, local competition in the manufacture and supply of electrical fittings appears likely to continue and even possibly to develop. British firms should make a point of doing their best to secure as much as possible of the business in these goods.

Payment by Results.—The Inst. of Industrial Administration announces that at 8 p.m. on Tuesday, January 9, at the London School of Economics, Sir Lynden Macassey will take the chair at a lecture on "The Future of Payment by Results," to be given by Mr. J. E. Powell, author of "The Output Problem." The meeting will be open to the public, and discussion will be invited.

West Indies.—It appears that the bulk of the electrical apparatus used in the West Indies is imported from the United States, and this is mainly due to the fact that most of the actual installations are American and use American standards. It is to be hoped that British engineers will do their best to meet this competition and turn the trade towards this country. The goodwill is directly in our favour.

New "Work" Handbooks.—Two useful additions to the famous "Work" Handbooks will be made on January 11, when the House of Cassell will publish "The Simple Lathe and its Accessories" and a companion volume, "Metal Turning Made Easy." Craftsmen will welcome the appearance of these books, the first of which gives descriptions of typical lathes and notes on their practical employment, while "Metal Turning Made Easy" is an up-to-date treatise on modern lathe-work practice, and explains in detail the various operations of turning, boring, screw-cutting, etc. Both handbooks are amply illustrated.

Finsbury Old Students' Assocn.—A Smoking Concert will be held at the Engineers' Club, on Friday, January 19, when the Chair will be taken by the new President, Mr. W. M. Mordey, M.Inst.C.E., M.I.E.E., at 8 p.m. Tickets 2s. 6d. each, may be obtained from Members of the Council or from the Hon. Secretary, H. P. Guy, 74, Silver Street, N.18. An Informal Dinner, at 6.45 (5s. 6d., payable at the Club), will also be held, but it is essential intending diners notify Mr. Guy beforehand of their intention to be present.

A Useful Gift.—Installation contractors and others will appreciate the penknife sharpener slip which is being presented to their customers by Pelican Electric Co., Ltd., of Beehive Wharf, Brentford, who are manufacturers of conduit tubes and fittings. The sharpener should help to keep in order the pencils used for signing orders to the company in the manifold books which are in the possession of so many installation contractors and readers of ELECTRICITY. Trade readers who wish to have one of these mementos should therefore make early application.

Motor Shipbuilding.—It is well known that 1922 has been a year of intense depression in the shipbuilding industry. Yet the tonnage of motor vessels completed in this country and abroad was greater than has ever been recorded in any previous year. Statistics are published in the current issue of *The Motor Ship* relating to the output of the last twelve months, from which it appears that the total deadweight tonnage of motor ships completed in the year was 429,465 tons, against 333,475 tons in 1921, which itself represented a record.

Ask for a Copy.—Messrs. W. H. Willcox and Co., Ltd., of 38, Southwark Street, London, S.E.1, who are so well known as specialists in engineering supplies of every description, are issuing their usual calendar for 1923, and are anxious that every man in charge of electrical plant and machinery should have a copy, so interested readers should make a point of writing them and asking for it, mentioning this notice. Don't leave it until too late.——A useful monthly calendar with an adjustable daily indicator, is being issued by Messrs. Francis Polden and Co., Ltd., electrical engineers and contractors, of 56, Cannon Street, E.C.4, and 17, Wells Street, W.1, and is certain to be appreciated by their many clients.

Two Friendly Reminders.—No, not bills, but just kindly gifts to smooth the pathway of 1923 have come from our good friends the Metropolitan Vickers Co., Ltd., and Bruce Peebles and Co., Ltd., respectively. The former takes the form of a miniature Cosmos Radiator arranged as an ash tray, which will prove useful to all editors as well as to smokers generally who may be lucky enough to get one, while the latter is a unique desk calendar, substantially constructed of art metal with a very nobby arrangement by which each date is mechanically and effectively cancelled. It has found a home in the editorial desk without any delay, and will be carefully watched so as to avoid its mysterious disappearance.

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A POPULAR SCIENTIFIC WEEKLY JOURNAL
ELECTRICITY
A PRACTICAL TRADE JOURNAL

JANUARY 12, 1923.

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AUTOMATIC HYDRAULIC REGULATION OF FURNACE ELECTRODES.

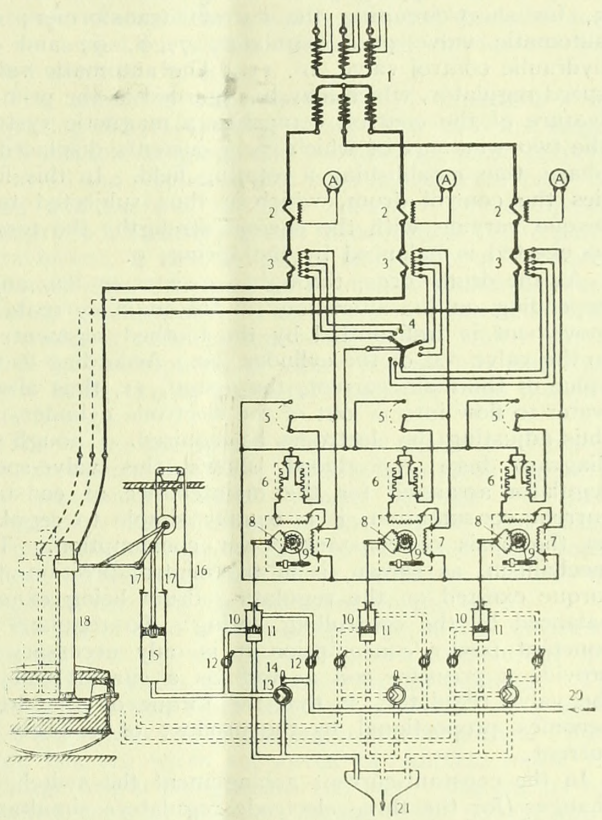
The many electric arc furnaces now used in the iron and steel industries offer a great field for a reliable method of automatically adjusting the position of the electrodes. Hand regulation, particularly in the case of small furnaces, is prohibitively expensive in labour costs. For larger furnaces, electrode control by means of electric motors may be employed, but, according to *Technische Rundschau*, this method of regulation does not easily permit of economical use of energy supplied to the furnace, for reasons which are given later.

The purpose of the electrode regulating devices is to adjust the position of the electrodes with regard to the furnace charge so that the current consumption of the furnace remains as nearly as possible constant. The whole of the electrical equipment can then be designed on the basis of a mean current value, and current fluctuations which would be objectionable to the supply authorities may be avoided. Though the last-named consideration is not so important in large modern supply networks, it is quite usual for the supply station to prescribe the limiting value of permissible current surges. Where lighting supply is taken from the same mains, this proviso is very necessary, and, in any case, excessive current variations involve inefficiency and inconvenience all round.

Now the power consumption of the arc depends upon the working voltage of the furnace, and this demands a certain distance between the electrodes and the furnace charge. Unfortunately the actual distance varies continuously, especially during the melting period, and it requires the whole attention of the man at the electrodes to maintain the correct setting. Indeed, on the larger furnaces it requires a man at each electrode to maintain satisfactory operation.

For years past a number of firms have tackled the problem of regulating furnace electrodes automatically by electrical means. Motors for raising and lowering the electrodes may, for instance, be controlled by relays which depend for their action upon the arc current or voltage, but constant care is required to keep the regulating contacts in good order. Unless such attention can be guaranteed, the reliability of operation, under steel works conditions, is apt to be low. This difficulty is, however, perhaps less serious than the problem of moving quickly and accurately the very heavy mass of the electrodes and their supports. Thus the electrode of a 15-ton Héroult furnace weighs nearly $2\frac{1}{2}$ tons, including the carrier arms and accessory fittings; in order to develop conveniently the considerable force required to move this weight it is necessary to provide between the motor and the electrode an elastic coupling and a gear or rope tackle of considerable mechanical advantage. Slow movement and more or less hunting or oscillation can hardly be avoided.

The hydraulic system of electrode control, developed by Brown, Boveri and Co., and now to be described, provides a direct-acting mechanism which requires no sensitive relays, is free from delay in operation, and has no backlash or overshooting. Without interrupting or affecting in any way the operation of the furnace, the hydraulic gear can be controlled automatically or by hand. The general nature and electrical connections of the equipment are shown clearly in the accompanying illustration, reproduced from *Trua.*



The whole of the control gear is mounted on a switchboard which is, preferably, placed in a cabin so situated with regard to the furnace that a clear view of the latter can be obtained from the control board. Normally the regulating mechanism will operate on any water pressure from 60 lb. to 150 lb. per sq. in., and can thus be connected to an existing water supply.

Referring to the diagram, the procedure for hand regulation is as follows :—The position of rest of the electrode, 18, corresponds to the middle position of the hand-regulating valve, 13, the handle, 14, of which is

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then in the perpendicular position. The water stop-cocks, 12, are then closed. According as the lever, 14, is moved forwards or backwards, water under pressure flows through 13 either into the electrode cylinder, 15, or out thereof, the electrode consequently either rising or falling. In the latter case, the descent of the electrode is caused by the only partially balanced weight of the electrode and its supporting arm, etc., and the rate of descent is determined by the position of the lever, 14, which varies the opening of the valve, 13. Maximum velocity of electrode movement (for emptying the furnace or skimming) is obtained by pulling 14 right back.

If automatic regulation is required, the hand-operated valve, 13, is placed in the closed position (with 14 vertical) and the two cocks, 12, are opened. Automatic regulation is then immediately established without the operation of the furnace being interrupted in the slightest degree. Pressure water can now pass to the electrode cylinder, 15, through the control cylinder, 10, when, and only when, the control piston, 11, does not interrupt the flow.

For each electrode the principal components of the automatic control are: One current transformer, 3, with various tappings; one change-over lever switch, 5, for short-circuiting the current transformer; one automatic valve-speed regulator, 7, 8, 9; and one hydraulic control valve, 10, 11. The automatic valve-speed regulator, which may be regarded as the primary feature of the control, comprises a magnetic system, the two windings of which carry currents displaced in phase, thus establishing a rotating field. In this field lies the control drum, which is thus subjected to a torque varying with the current strength; the torque so exerted is balanced by the spring, 9.

As the drum turns, through a greater or less angle depending on the alterations in the main current, its movement is transmitted by the toothed segment, 8, to the valve rod of the cylinder, 10. According to the value of the main current, the piston, 11, thus allows water to flow into or out of the electrode cylinder, 15, thus adjusting the electrodes as required. Though the diagram here reproduced shows the valve-speed regulator arranged for the maintenance of constant current consumption, it is equally simple to regulate on the basis of constant power consumption. The mechanism, as shown, is in the neutral position, the torque exerted on the regulating drum being exactly balanced by the controlling spring. To regulate for constant power consumption it is only necessary to provide a pressure coil as well as a current coil on the valve regulator, so that the torque on the drum becomes proportional to the product of voltage by current.

In the constant-current arrangement the switch, 4, changes (for the three electrode regulators simultaneously) the tapping used on each current transformer, so that $\frac{1}{2}$, $\frac{3}{4}$, $\frac{4}{4}$, or $\frac{5}{4}$ of the normal current is applied to the regulator field. Intermediate settings can be obtained by adjusting the tension of the spring, 9, and, by these two means together, any desired current value can be maintained in the electrode circuit.

The construction of the valve regulator and valve is well adapted to the requirements of electric furnace operation, particularly as regards the elimination of unnecessary regulation; thus small departures from the desired constant current are corrected slowly (without risk of overshooting), whereas wide variations of current are corrected promptly.

In the event of the supply voltage at the furnace transformer falling to zero for any reason, the current would also become zero and the electrodes would be lowered by the automatic gear, with disastrous results when the supply was resumed. To eliminate this possibility it is only necessary to inter-connect a no-voltage relay with the valve regulator in such manner that the electrodes are automatically *raised* in the event of voltage failure.

Tests on a 5-ton, 3-phase furnace fitted with the automatic hydraulic regulation described show that the power fluctuations during the melting of a charge were about ± 5 per cent. compared with ± 40 per cent. when relying upon manual adjustment of the electrodes. Amongst the other advantages claimed for the system described, the following may be mentioned: No motors are used at the furnace for the electrodes; no contacts or regulating devices are exposed to foundry conditions; no regulating resistances are used to control the energy supply; the electrodes descend only by their own weight, hence there is no risk of breaking them by forcing them against obstacles; the load factor of the electrical demand is improved; and a higher degree of uniformity is maintained in the metal produced

HOW ELECTRICITY HELPS THE FARMER.*

On Saturday, November 25, a crowded and appreciative meeting of the Bedford Park Natural History and Gardening Society attended the lantern lecture given on the above subject by Mr. H. A. Carney (who is associated with the work of Mr. R. Borlase Matthews, the apostle of electro-farming in this country). From the comprehensive series of slides shown (many from photographs taken at Greater Felcourt), it is clear that electricity has already been applied to every power purpose on the farm, from milking to ploughing. According to data given by the lecturer the consumption of electricity is relatively trifling, the energy which will light a 40-watt lamp for 25 hours being sufficient, for instance, to chaff half a ton of hay or cut up 6 tons of swedes, or milk 52 cows, or churn and make 165 lb. of butter. The work in all cases is accomplished without physical exertion and in a fraction of the time possible by other methods.

Electro-culture or the electrical stimulation of plant growth was referred to as a proven possibility, and one likely to be of all-round benefit to the farmer, who can rely upon a minimum increase of 10 per cent. in his crop yields from its application. Instances of much higher yields were mentioned, up to 50 per cent. increase, for instance, for wheat, oats and potatoes, the annual financial gains varying (at pre-war prices) from £3 10s. to £15 per acre. It appears, however, that the necessary equipment has not yet been developed on a commercial scale for really practical work on farms.

The use of electric light as an aid in the increased production of new laid eggs in winter was one of the

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more striking illustrations of the all-round utility of electricity to the farmer. The increase is from 10 per cent. to 25 per cent. over the number of eggs normally laid per hen during the winter.

The most striking instance of all was the production of good hay, under exceptionally unfavourable conditions, direct from grass cut wet and stacked immediately. Several slides were shown of the process at work and samples of the actual produce were exhibited.

A number of questions were asked at the end of the lecture and several further interesting facts were elicited. It appears that the success which attended the electric haymaking has since been repeated on a large farm whose corn crop, extending to several hundred acres, was in danger of rotting on the fields. By installing suitable equipment the crop was saved and is now being thrashed. Even in fruit growing it seems that electricity may be useful, for a further question brought forth a reference to some experiments being carried out in New Zealand, where electric lamps are hung in the fruit trees. Asked whether the use of electricity on farms would not lead to increased unemployment owing to the quicker working and consequent displacement of men, the lecturer replied that on the contrary, by increasing the producing capacity of farms and of the labour employed, the extended use of electricity in agriculture, eliminating the more monotonous and the heavier part of the work, the status of the farm worker would be raised, his standard of living improved and his wages increased because of his increased productive capacity.

WIRELESS.

The Manchester Broadcasting Station.

Now that the British Broadcasting Company has been formed, and is actively functioning, some brief particulars of one of the principal broadcasting stations should prove of interest. The company, it will be recollected, is composed of a group of manufacturers, which will ultimately operate at least eight stations respectively in London, Manchester, Birmingham, Newcastle, Cardiff, Plymouth, Glasgow and Aberdeen. Any bona-fide British manufacturer can join the company on nominal terms, and the expense of maintaining the stations is to be provided partly by the Government remitting to the company a portion of the receiving licence fee and partly by the manufacturers themselves. At present three stations are operating—London, Birmingham and Manchester.

The Manchester station is situated in the Research Department of the works of the Metropolitan-Vickers Electrical Co., Ltd., at Trafford Park. The M.-V. Co. is technically very closely associated with the pioneers of the broadcasting movement, the Westinghouse E. and M. Co., of Pittsburg, U.S.A., and has put on the market a complete line of apparatus, including a crystal set, a 2-valve set and loud speaker, and is proceeding to market almost immediately larger sets for listening over greater distance.

At the Manchester station the power for the transmitting set is supplied by a small generator in the works power house at 440 volts, 50 cycles, 3-phase, and this is employed to drive a triple set consisting of an induction motor, high-tension generator and exciter supplied by Newton Brothers, Derby. The high tension generator is rated at 2.5 kw. at 5,000 volts and runs at 1,500 r.p.m. Two of these sets are installed, and a complete change-over of drive and supply can be effected in emergency by throwing over a single switch from one side to the other. Suitable filter circuits are provided at the high-tension generator to remove the commutator ripple. The field of the high-tension generator is fed from the exciter through a potentiometer type field regulator. This enables stable adjustments to be obtained even down to very low voltages, which are occasionally required for test and experimental purposes.

The transmitter panel was installed by the Radio Communication Co., of London, and employs Mullard o-500 valves. The high-tension D.C. supply at 5,000 volts is fed directly to the anodes of the valves and suitable protective gear is provided to protect the generating set against short circuits. The transmitter is installed in a small transmitting room. While a special listening station is provided some miles from Trafford Park, the character of the modulation is checked also in the transmission room. The filament of the transmitting valves is heated from a 30-volt battery. An artificial aerial is provided to enable tests to be carried out with a minimum of interference with other users of the ether.

The studio is accommodated in a spacious room adjoining the transmitting room. The walls are draped with suitable hangings and the floor has been carpeted to avoid the resonance and echo encountered from the floor and walls of ordinary rooms. The equipment comprises a Steinway grand piano with a Welte player attachment, a new Edison gramophone of the latest diamond-disc type, and an Aeolian Vocalion Graduola cabinet gramophone. The studio is connected to the transmitting room by multi-core cables, which may be used for microphone or other control circuits, these latter being run in a separate cable to avoid inductive interference.

The music and speech from the studio is picked up by microphone or other suitable apparatus supported on convenient stands. These sounds are given preliminary amplification in the studio, and passed through the microphone cable to the transmitting room, where further amplification is carried out before the amplified currents are impressed on the aerial.

The aerial used is of the cage-type, and is suspended between the top of the well-known water-tower and the highest point of the main works building. The lead-in is taken from the centre of the main aerial and drops into one of the research laboratories. Each cage has six wires supported by suitable loops, the average height being about 160 feet. The station has worked, since its inception, on 800 watts, but the power is being increased almost immediately to 1,500 watts, the full power for which it is licensed.

A small experimental station, capable of transmitting 100 watts, has been erected at Hale. Here a single-phase induction motor on the Altrincham Electric Supply driving a high-voltage generator of 1,500 volts at 1,500 r.p.m. is used with an exciter. This station acts partly as an independent experimental station and partly as a control for the main broadcasting station, and is equipped with various receiving sets for "listening-in." The aerial is 150 feet long, and com-

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prises a triple wire with 12 feet spreaders at a height of 75 feet.

In conclusion, we might add for the benefit of those who still do not know, that for authorisation to receive radio-telephony all that is required is the purchase of a broadcasting receiving licence from the Government. This can be obtained from the chief post office of any town or village for the sum of 10s. Care is required in the selection of a receiving set, and the prospective buyer should see that the set is one in which the operation is made as simple as possible. Crystal sets are useful under ordinary conditions within 15 miles of a broadcasting station, using 1,500 watts, although reception has been reported in exceptional cases over distances several times greater than this. In addition to the crystal set, 2-valve sets and 4-valve sets, etc., the M.-V. Co. is shortly putting on the market a note amplifier, which, used with a loud speaker, will enable everyone in a room to hear what would in the ordinary way be heard only in the telephone receiver. This note amplifier can be applied to any set. For those people who live in flats or who have difficulty in erecting an outside aerial a special set containing several valves is being developed for use with an indoor aerial.

NORTHAMPTON INSTITUTE: PRIZE DISTRIBUTION.

The distribution of certificates and prizes awarded during the session 1921-1922 to the students of the Northampton Polytechnic Institute, Clerkenwell, E.C., took place recently. The proceedings gained in interest by the fact that Dr. S. Z. de Ferranti presented the prizes, and that among those on the platform was the Astronomer Royal. The meeting in the large hall at which the distribution took place was presided over by Mr. L. B. Sebastian (Chairman of the Governing Body). Recitals on the organ preceded and followed the meeting, while throughout the evening the whole building was thrown open to visitors, who had full opportunities of seeing the machinery and apparatus in operation. Demonstrations were given for their benefit in the electrical and other laboratories; there were exhibits of students' work, and lecturettes on interesting subjects. Besides these there were displays in the gymnasium and swimming bath. The proceedings were throughout interesting and animated, as one expects of such a very busy place when it is in a holiday humour; indeed, we thought the boys who will be boys, and who demonstrate the fact by wearing jelly bags, throwing streamers, marching behind a carrot, and so forth, were a little more in evidence than usual. However, the older people bore these antics very good humouredly.

In the course of a report which he read at the meeting, Dr. Walmsley stated that in the Engineering Day College the number of enrolments had been 295 in October, 1920, and 286 in October, 1921. In the earlier year the figures had been largely increased by an influx of ex-Service men. An interesting point with reference to the fourth year men, who completed their courses in July, 1922, was that included among them were not only students who had joined in the regular way in 1918, but also a fairly large influx of the ex-Service men who had rejoined the College early in 1919 after the Armistice. The result now was that there was the record number of 28 Engineering Day Certificates to be awarded. In addition to this, of the 19 students who had been presented for the B.Sc. examination of London University 17 had passed—some with first and second class honours. An unfortunate feature of the year's work had been in connection with the students who should have been placed out in works early in April. The engineering dispute had upset all such arrangements, and of the 169 students who were qualified to be sent out into works, and all of whom would otherwise have been sent, only 126 were eventually placed out, and nearly half of these in works in France, Belgium and Switzerland. The amount of work accomplished in all the day courses might be obtained from a statement that the number of student-hours worked in these courses and classes had been over 244,000. The corresponding figure for last year had been 261,000: both figures were far in excess of anything which could be reported in pre-war times. (Applause.)

Speaking of the evening work, the Principal said that the total enrolments had reached 6,166 class entries by 2,034 individual students, as against 6,458 by 2,624 individual students in the preceding session. From these figures it was evident that the individual students were on the average taking more classes than previously. The total number of hours worked had been 166,147, as against 165,146 in the preceding session. Notwithstanding therefore a decrease of nearly 600 individuals, the work done had been actually greater than in 1920-21. The loss of nearly 600 students here alluded to had been mainly due to the fact that the fees for all evening courses had been substantially raised, especially in the case of students not residing within the county of London. (Applause.)

Of the social side of the Institute's work the Principal said that the membership of clubs and societies had risen from 1,242 to 1,325. (Applause.)

The presentation of prizes and certificates followed.

Mr. Frank Gill (President of the Institution of Electrical Engineers) moved a vote of thanks to Dr. S. Z. de Ferranti. Electrical engineers, he said, were not indifferent to their great men. Dr. Ferranti had pioneered in high tension electric engineering, and those who had received certificates and prizes would value them the more because they had receivd them at his hands. (Applause.) Throughout his life Dr. Ferranti had been an encourager of the young, and it must have been a peculiar gratification to him that evening to hand a prize to Mr. Robert Hicks Walmsley, a son of the Principal. (Renewed applause.)

Mr. W. R. Corke (Mayor of Finsbury) seconded the resolution, and the vote of thanks was heartily accorded.

A vote of thanks to the chairman, proposed by Sir Frank Dyson, M.A., etc. (Astronomer Royal), and seconded by Dr. W. Garnett, concluded this part of the evening's proceedings; but the demonstrations, exhibitions, etc., previously alluded to, continued to a much later hour.

Camden, N.S.W.—A meeting of business and professional men of Camden was held recently to discuss the proposed electric lighting and power plant for the town. The meeting unanimously decided that an electric lighting and power plant was urgently needed, and appointed a committee of seven to interview an expert electrical engineer and secure plans, specifications, and an estimate of the cost of installing a plant.

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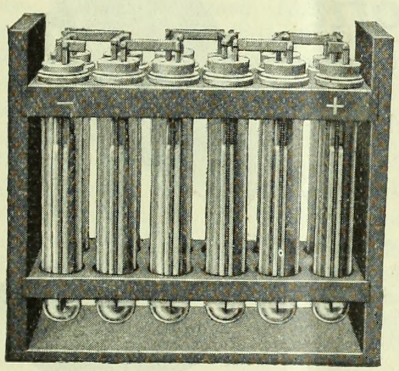
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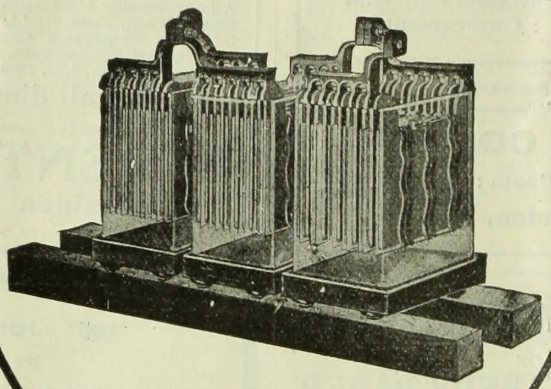
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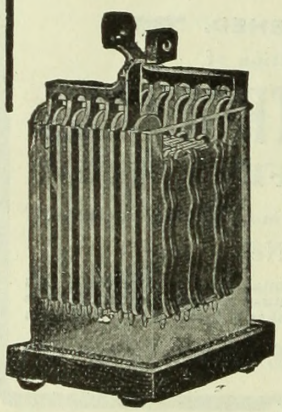
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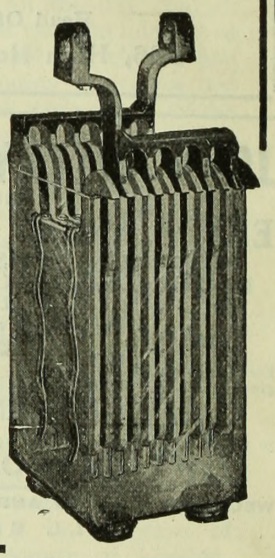
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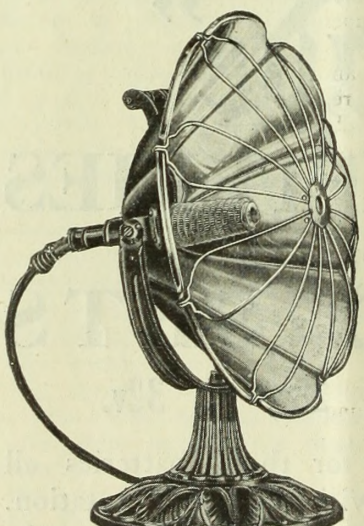


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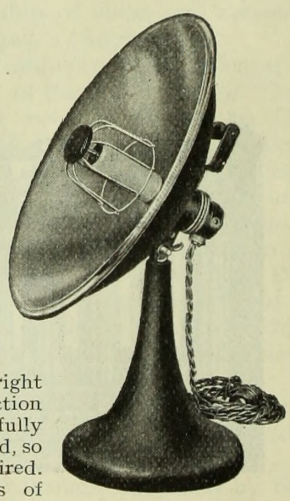
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TO OUR READERS.

ELECTRICITY is published every Friday, and, if ordered, is on sale at the principal Railway Station Bookstalls and Newsagents on that day. It has a very large sale throughout the United Kingdom, as well as in the British Colonies and Abroad.

Questions to which an answer is required must be accompanied by a 1½d. stamp for reply. When considered of sufficient interest, the answer will probably appear in the paper.

New advertisements for the displayed columns and alterations to existing ones must reach the publishing office not later than first post Tuesday morning, in order to be in time for the issue of the following Friday. This is important. Rate quoted on application. Subscription: 13s. a year, 6s. 6d. half year, 3s. 3s. a quarter in advance, postage prepaid in the United Kingdom and abroad.

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Current Topics.

A Self-Supporting Empire.

Little more than a month ago I wrote on this same subject, as prompted by the appeal of the British Empire Producers' Organisation, and pointed out how necessary it was to encourage co-operation as between the Colonies and the Mother Country in the matter of interchange of goods, foodstuffs, raw materials for industry, etc., the better to cope with the growing foreign competition, which reacts alike against Great Britain at home and her Colonies and Possessions overseas. Largely self-governing, our various Colonies are perfectly entitled to legislate for themselves in matters of individual concern, and we at home can safely leave them to enact laws calculated to secure the maximum benefit for their populations, having regard to all local circumstances.

In the matter of inter-trading with the Mother Country, however, there should be a common inter-Colonial policy regarding tariffs, imports, exports, and all matters affecting trading relationships between our Colonies and ourselves, the ultimate object being to encourage trade within the Empire as far as is practicable, and, furthermore, render the Empire self-supporting. In view of these desiderata, which I think every Briton or Colonial will agree with, it is difficult to sense the equity or logic of the individual or individuals who in the first instance imposed and apparently still maintain a duty to the extent of 8d. per lb., or 35 per cent. *ad valorem*, on British catalogues imported into Australia. A manufacturer's or trader's catalogue is in itself an essential certificate of his desire to do business. It deals with the goods he has to sell and is the only means available for bringing those goods to the more or less immediate personal notice of prospective buyers.

To place what amounts to be a partial embargo on the entry of British catalogues into British territory is entirely contrary to the spirit of Empire trade expansion, and it is difficult to discover a plausible excuse for such a policy. One can understand that Australia, like certain other portions of the Empire, desires to promote home industries, and to this end is prepared to protect the interests of her own manufacturers even at the expense of home competitors, but this in itself is no justification for a duty on catalogues in general. Another alternative reason which might be advanced is that the imposition of a duty on British catalogues entering Australia prompts British manufacturers who desire to trade with Australia to have their catalogues printed in that country. Such an argument, however, scarcely holds water, inasmuch as, if carried to a logical conclusion, it would necessitate considerable and unnecessary additional expense in printing a common catalogue in small quantities, at widely separated points, and in such numbers that the costs of production would be increased out of all proportion.

Furthermore, there is the educational value of the catalogue which is allowed free circulation throughout the Empire. Enterprising manufacturers and traders spend much money and effort to provide interesting, educational, and instructive illustrated catalogues and price lists describing their goods, and it is largely by this means that colonists and dwellers in the far-flung areas of the British Empire are kept advised and in touch with what it is possible for them to obtain under an advanced civilisation. Thus a duty on catalogues not only penalises the trader who issues it, but also the Australian up-country, who is left guessing as to the resources of the Mother Country. I am glad to note that the Australian Association of British Manufacturers and their representatives have brought this anomalous duty and its disadvantages to the more immediate notice of the Minister for Trade and Customs, who must in the natural order of things refer it to the Tariff Board. I can hardly imagine that this latter body realises the existence of such a duty and what it involves.

Room for Economy.

In no other branch of public expenditure is there such ample scope and pressing need for the application of the "axe" than in education. Practically every other trade or profession, save that of teaching the young, has submitted to an inevitable reduction in salaries and wages. Not so the schoolmasters, mistresses, and teachers under the Board of Education, who are regarded as very generously inclined towards the public purse, because they agree, through their organisation, the National Union of Teachers, to a cut of 5 per cent. in salaries for the year beginning April 1 next (significant date). In five years the cost of educating children in the free schools of England and Wales has nearly doubled, whilst by comparison with pre-war figures it has more than doubled. And what do you get for it? The average child, leaving an elementary school, is no better fitted, if as well, for facing the battle of life than when the three R's were taught on a very primitive but fairly effective plan, at a hundredth of the cost of educating the children of to-day.

The whole scheme of education needs revision, root and branch; it is too costly for our present resources and, what is more, the ratepayer and taxpayer who foot the bill do not get anything like value for their hard-earned money. I have no quarrel with teachers as a class; they are at present on velvet. They work shorter hours than practically any other class of the community, enjoy longer and more frequent holidays, and have every facility for pursuing spare-time employment or attractive hobbies. They are perfectly entitled to their good time, provided I am not called upon to pay an unreasonable education rate and corresponding quota of imperial taxation to maintain them. On the whole, they are a prosperous section of the community;

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there are three married teachers living opposite me who bought and still own their own houses prior to the war. I wonder what my individual contribution was towards those three houses and how it figures in the annual cost per child educated. The fact remains, education, under present conditions, is far beyond the capacity of the country to pay, and the Chancellor's investigations towards a healthier Budget may concentrate on this branch of expenditure, with every prospect of netting a respectable balance to the good.

Broadcasting and the Influence of the Amateur.

In my last week's notes I commented on the very abstruse document which applicants for an "experimental" wireless receiving licence were called upon to fill in, and suggested that this placing of further difficulties in the path of the keen amateur investigator was a poor return for the excellent pioneer work carried out by this section of the community in the past. Since those notes were written, two instances have come to my notice of the really valuable results accruing to wireless development from the purely voluntary research work performed by these amateur enthusiasts. In the one case a series of experiments in Transatlantic wireless telegraphy under unusually economical conditions has just been completed at Wandsworth by members of the Radio Society of Great Britain, the amateur organisation formerly known as the Wireless Society of London.

Making use of the 170 ft. chimney of the County of London Electric Supply Company to support a six-wire "tubular" aerial, employing a wave length of only 200 metres and a maximum power of 1½ kilowatts for transmitting, this group of amateurs succeeded in sending recognised groups of signals to American amateurs, and which were successfully received by the latter on nine out of the ten days during which the trials lasted. When it is realised that the powerful and costly commercial Transatlantic wireless stations use for the same purpose wave lengths of from 15,000 to 30,000 metres and require anything from 250 to 350 kw. transmitting power, to say nothing of elaborate and extensive aerial systems, the significance of this amateur development work is better appreciated.

The other instance of amateurs beating the professionals at their own game hails from Manchester, where, speaking at a weekly luncheon of the Manchester Rotary Club, Mr. Y. M. P. Evans criticised the efficiency of broadcast transmission as at present practised by the Broadcasting Company at Manchester, Birmingham, and London, as well as Paris. Mr. Evans considers that the Trafford Park transmission, although consistently improving, is not yet equal to that from the other three stations mentioned, and went so far as to suggest that the Metropolitan-Vickers Company might with advantage approach the local amateur wireless society for advice on this subject, its members being responsible for a much more successful transmission both of speech and music!

ELEKTRON.

China.—The Sien Hsiung Electric Light Co., at Hungkiang, in Western Hunan, has been officially registered at the Hunan Civil Governor's Office.

LIGHTING PRITTLEWELL PRIORY.

When ancient monuments or historic buildings are being restored, either for private occupation or for public enjoyment, the question of artificial illumination always arises. Electric lighting is generally selected, and much care is exercised in the production of lanterns or fittings which shall be in keeping with the style or period. Sometimes, alas, in spite of this, the effect is ruined by unsightly conduits, switches and other accessories. This, happily, has not occurred in the recent restoration of Prittlewell Priory, which was acquired in 1917 by Mr. R. A. Jones, of Southend-on-Sea, and was presented by him to the borough as a place of public recreation. Of the original buildings only the Refectory and the Prior's Chamber now remain These have been restored, and with the exception of two rooms at the junction of the old buildings, all modern additions were removed—the two retained having been adapted for museum purposes.

The electric lighting was entrusted to a local firm, Messrs. P. Richards and Co., and they are greatly to be congratulated on the manner in which the installation has been carried out without obtruding unsightly wiring or accessories. The fittings are to the design of Mr. Philip M. Johnston, F.S.A., F.R.I.B.A., and are simple oak corona pendants with three lights in each for the larger rooms, and single light drops and ceiling lamps of similar design in the corridors and smaller apartments. All are equipped with Osram Axial type lamps.



FIG. 1.—PRITTLEWELL PRIORY: THE REFECTORY.

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With the object of avoiding cutting away the original roof timbers and other parts of the fabric, and to render the wiring as inconspicuous as possible, the "Kingsway" wiring system, developed by the General Electric Co., Ltd., was selected. As our readers are no doubt aware, this is a simple system employing lead-covered wires, with a special back-plate and continuity clips at all junctions and outlets, also special junction box covers and wiring clips, but otherwise utilising standard wiring accessories. Wherever new walls were available, these were chased to receive the lead-covered cables, but on the roof beams and other positions the wires are run on the surface, where, as will be seen in the photographs reproduced herewith, they are not

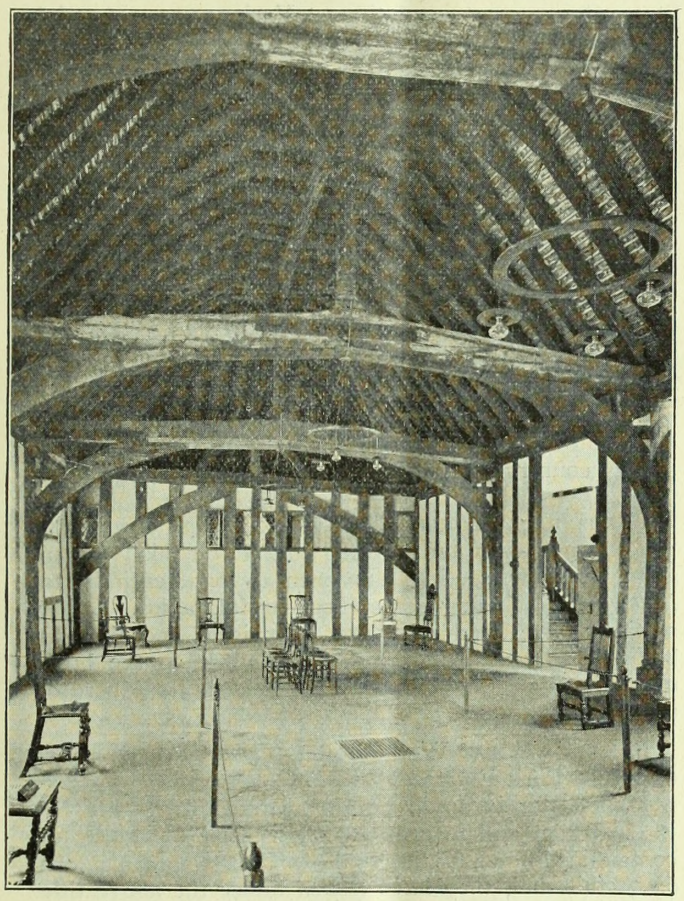


FIG. 2.—PRITTLEWELL PRIORY: THE PRIOR'S CHAMBER.

at all conspicuous, in spite of the fact that the photographs were taken only a few days after the installation was completed and before the lead covering had become tarnished.

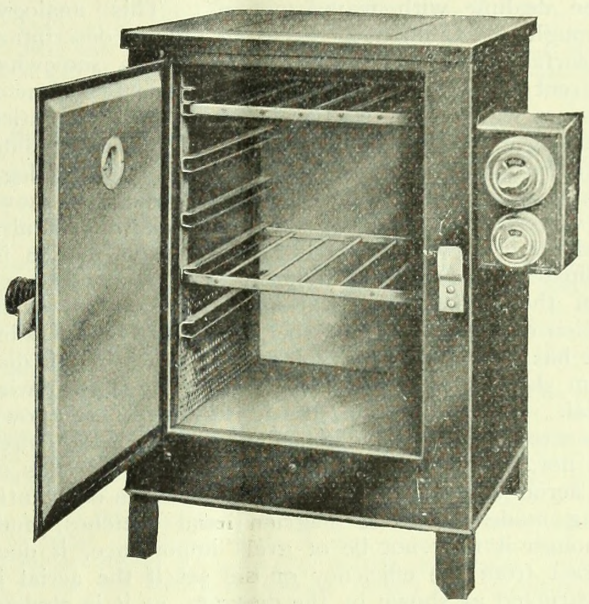
The Refectory (Fig. 1) has been restored almost exactly to its original condition. It would have been little short of criminal to run conduit on these wonderful oak beams, but the lead-covered cables are practically invisible. They are run as far as possible on the tops of the beams before they drop down the side to the fittings. The whole of the Refectory lights are controlled from one corner.

Fig. 2 is a view of the Prior's Chamber on the upper floor, which has been treated in a similar manner to the Refectory.

Thanks are due to the Corporation of Southend-on-Sea for permission to take and publish photographs of the building, and also to Mr. William Pollit, F.L.A. (Dip.), chief librarian and curator, and Messrs. P. Richards and Co., electrical contractors of Westcliff, for their help in preparing the matter.

"MAGNET" ELECTRIC COOKERS.

In a new folder (No. H. 2,867) the G.E.C. give particulars and prices of a series of "Magnet" electric cookers, covering all requirements from those of the bachelor to a family of twelve persons. For the family which does not exceed eight there is an inexpensive range, of substantial sheet-metal construction, double cased, and well finished in black enamel, with bright metal relief (see accompanying illustration).



The oven measures $25\frac{1}{2}$ in. high by 18 in. wide and $15\frac{1}{2}$ in. deep overall, the oven space being $17\frac{1}{2}$ in. by $10\frac{1}{2}$ in. by $12\frac{1}{2}$in. There are three heating elements, two at the sides of the oven and one at the top. The top element is used not only as an auxiliary heat for the oven, but also for grilling, toasting and boiling. The maximum loading of this oven is 2,700 watts, variable in 15 steps, down to a minimum of 300 watts.

Correspondence.

A CORRECTION.

To the Editor of ELECTRICITY.

DEAR SIR,—In my answer to Question No. 151, published in your issue for January 5, 1923, please read: In the winding space we can have 13 layers of 120 turns each of No. 20 d.c.c. copper wire. This will be 1,560 turns. We want 5,483 ampere turns.

$$\therefore \text{ current } = \frac{5,483}{1,560} = 3.5 \text{ amps. (approx.)}$$

Yours faithfully, "M. M."

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Reviews of Books, &c.

[Books noticed in this column will be sent from ELECTRICITY *Office to any part of the world, for the published price, plus ten per cent. for postage (minimum 2d.) and orders will be appreciated.]*

WIRELESS TELEPHONY. By R. W. Hallows, M.A. (Pearson. 1s. 6d. net.)—This small book is written as a first guide to the beginner, who wishes to gain a general idea of the "hows" and the "whys" of wireless telephony, and it further describes in simple language and with clear sketches how the simple home-made crystal set may be constructed and used. The author in his foreword mentions that he uses analogies which must not be stretched too far. Some of the analogies that he uses are extremely good, and help towards a clear understanding of the subject. For instance, in the usual elementary book of radio, a stone dropping into a pond is, as a rule, described when dealing with wave motion. This analogy, although so common, is after all only a description of surface waves, whereas we require a somewhat different analogy, which more readily makes clear a pressure wave. Mr. Hallows' description of the stick swinging to and fro in the pond more closely indicates the nature of the wireless wave than the analogy mentioned above. The description and diagram showing waves travelling out in ever-widening circles is also good, as it shows so clearly how the wave motion is dissipated, and how receiving sets at some distance from the transmitting station only receive a small portion of the transmitted energy. There is one point that has been overlooked, and this occurs in the diagram showing the method of making up a twin wire aerial. In this diagram, the lead-in wires are shown connected some little distance down the aerial wires and not, as they should be, connected to the ends of the aerial wires. This is an error which is constantly being made on aerial diagrams and sketches, and, although it may not be of great importance, it does detract from the efficiency of the set if the aerial is constructed as shown by the diagram, as it is obvious that such an aerial will have two different natural wave lengths. The book does fulfil its object, and it should be of use to the amateur, as it does very clearly and concisely explain the theory of wireless telephony. The constructional portion relating almost entirely to crystal sets is clear, but the construction of the set described is crude.

THE BOOK ON RADIO. By Charles William Taussig. (Appleton, New York and London. 16s. net.)—This book is essentially American, and, as claimed, does give a popular and clear description of radio apparatus and its use, and also outlines the development and application, both public and private, of the science up to the present day. The amateur will find in the book material of practical usefulness, but we do not agree that the professional will find the book of very much service, as it is essentially a popular treatise. As stated above, the book is essentially American, and quite a number of its chapters, while of interest, are of very little use to the amateur in this country, except to give him an insight into the position in the United States of his favourite hobby. Like some other American books on the subject, there are many stories woven into the text, and also some history, so that in parts one has the impression of reading a novel rather than a book of science. For this reason it may not appeal to the English amateur, who as a rule prefers the "dry as dust" methods of explanation. The diagrams are, in general, those usually found in wireless text books, and the majority of the illustrations show the various standard catalogue articles sold by American manufacturers. A considerable amount of information on the United States Government Radio Service is given, on both the War and the Navy Departments, and also the Department of Commerce. A chapter is devoted to the United States Government regulations. Various types of aerial are described, the majority of which are not allowed by the Postmaster-General in this country. A chapter is given entitled "Radio Dictionary," and in this the description of some of the terms certainly lacks detail. For instance, "ampere" is described as "the electrical unit of current flow," "alternator—a machine for generating alternating current," "Henry—the unit of inductance," "kilowatts—1,000 watts," "volt—the unit of electrical pressure." It will be seen that the amateur looking up such words as these is not given a very great deal of useful information. To summarise the book, it does contain much information of value to the American amateur, but it is doubtful if much of the information is of interest, to say nothing of use, to the English amateur, and such information as would appeal to him is contained in books written in this country and sold at a very much cheaper rate.

MECHANICAL WORLD YEAR BOOK, 1923. (Emmott, 1s. 6d. net.)—In the current edition of this veteran annual a new section has been devoted entirely to fan work, including some most useful tables. Other sections have been rewritten or revised, and that on belting has been considerably extended, so the book maintains its high reputation and widens its sphere of usefulness.

BRITAIN'S GREAT WORKSHOP AND STOREHOUSE, 1923. (Trafford Park Estates, Ltd., Manchester.)

Manchester is again on the warpath in its bid for world trade, and in order to show what the group of companies known as the Trafford Park Companies can do to this end, they have issued under the above title a real work of art in the form of an illustrated book or brochure describing the facilities offered by Trafford Park as an industrial location, by the Port of Manchester Warehouses for storage of merchandise, by the Trafford Park Cold Storage for storage of meat and perishable produce, and by the Port of Manchester Road Service for the movement of traffic by road.

That is a fairly comprehensive schedule, but it is remarkably well done and reflects much credit on the enterprise of the companies who are anxious to extend their services and on the Cross-Courtenay Co., Ltd., who are responsible for the production of the book itself. It opens with a full-page photo of Marshall Stevens, who has been the vital force behind all the Trafford Park undertakings, and then goes on to the sections referred to above. Colour enters largely into the scheme, thus enhancing its attractiveness, while

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the photographic reproductions are large and numerous. They show the interiors of such works as the Ford Car Co., Metropolitan-Vickers Co., Glover, Lancashire Dynamo and Motor Co., Taylor, Bros. and Co., Redpath, Brown and Co., and other great firms whose works are on the estate. Also views of the docks, roads, sidings, cotton warehouses and, in fact, all the leading points of interest which will appeal to the manufacturer who is looking for suitable land on which to erect an up-to-date factory and will, so to speak, have the world market at its very doors. That is the object of the book, and for the sake of the British Empire and its export trade by which we live, we can but hope that it will have a wide circulation among enterprising men. It is worthy of it.

WHO'S WHO IN ENGINEERING DIRECTORY AND MANUAL, 1923. 4to, cl., 1,211 pp. (Compendium publishing Co. 28s. net.).—This is the third edition of this compendium, and its growth can only be regarded as phenomenal. It is nearly 500 pp. larger than the second edition, and, needless to say, it contains a vastly increased number of biographical notices, thus evincing the continued interest which engineers generally are taking therein. It must be remembered that British engineering is world-wide in the fullest possible sense of the term, so the list includes the names of representative British engineers who are worthily carrying on the traditions of the profession in all parts of the civilised, and frequently very uncivilised, globe. Much of the great export trade of this country is due to the indents prepared and sent home by these true ambassadors of commerce, and the growth of a book of this nature is therefore of double value. It indicates the actual growth of our profession in all its branches, and it is, in addition, a directory of the men with whom manufacturers and contractors will wish to get in touch in order to push the advantage of their respective specialities. The book has also been extended so as to include details concerning the engineering societies and institutions in the overseas dominions as well as in Great Britain, and there are other new features which enhance its value, viz., Current Engineering Topics, B.E. Standard Specifications, Legal Notes and Statutes, Rules and Orders. Altogether we can most cordially recommend the book to firms and individuals as an investment which should repay its cost many times over.

We have to acknowledge the receipt from the Department of Overseas Trade of Reports on the Economic and Financial Conditions of Brazil (1s. 9d. net*), Australia (2s. 6d. net*), and Algeria, Tunis and Morocco (3s. 6d. net*). In each case there are sections dealing with electrical machinery, wireless telegraphy and telegraphs and telephones, and they are, therefore, of direct interest to British manufacturers and export merchants who wish to increase their present trade with those countries, or who seek to open up new branches, and thus develop the exports which we are all so anxious to send out. The D.O.T. is certainly doing its utmost to obtain information of value to the British trader, and it only remains for that information to be utilised to the utmost.

* Prices 2s., 2s. 9d., and 4s. respectively, post free from ELECTRICITY office.

Various Items.

Tenders Invited.—The Municipal Council, Johannesburg, invite tenders for an 8,000-10,000 kw. turbo alternator set. Details from the D.O.T. (Room 49), 35, Old Queen Street, Westminster, S.W. 1.

Tenders Wanted.—For the installation of electric light in the Infirmary at Raine Street, London, E.1. For details see official advertisement on the prepaid page.

I.E.E. Visit.—On Saturday, the 13th inst., there will be a visit of the London Students' Section of the Institution of Electrical Engineers to Messrs. Morgan Crucible Co.'s Works at Battersea.

Meetings.—The I.E.E. will meet in the Lecture Theatre of the Institution, Savoy Place, Victoria Embankment, W.C. 2, on Thursday, 18th inst., at 6 p.m. Paper, "Works Production," by G. H. Nelson (Member).

I.E.E. Members' Dinner.—Arrangements have been made for the members of the I.E.E. to dine together at the Engineers' Club, Coventry Street, W., after the ordinary meeting of the Institution, to be held on January 18. The charge per cover will be 5s. 6d.

Osram Robertson Staff Dance.—Saturday, December 30, was the date of the Christmas dance held by the staff members of the Osram-Robertson Social Club. It was given in the works dining hall, which was festively adorned for the occasion. Their own band provided excellent selections of music, and the addition of carnival novelties helped everyone to have a very enjoyable evening, which was shared by Mr. and Mrs. Wilson and Mr. and Mrs. Driver and friends. Thanks are due to Messrs. Vanhinsenbergh and Taylor for the excellent way in which things were organised.

"**Henley Telegraph.**"—It is worth something to be on the staff of W. T. Henley's Telegraph Works Co., Ltd.—to receive quarterly the "Henley Telegraph." The latest issue (December) has kindly been sent us and, as usual, is much appreciated. Among the many articles we note a full account of the recent presentation to Sir Geo. Sutton, Bart., a very interesting description of railway travelling in Brazil, also numerous notes, some long, some short, on all kinds of topics of interest to Henleyites (we would like to congratulate "B.P." on his clever piece of drawing), and as usual a most impressive list of recent orders for all sorts of wire and cable from all over the world.

Just Published.—The new edition of "Telephone Erection and Maintenance" by White is now ready, and can be ordered through any bookseller (3s. 6d. net), or it can be purchased direct from the publishers, S. Rentell and Co., Ltd. (ELECTRICITY Office), 36, Maiden Lane, London, W.C.2, price 3s. 9d. post free. This well-known work is recommended officially by the City and Guilds examiners, and as such is in constant demand for electrical installation work, so every reader interested in that subject should get a copy as quickly as possible. This new edition has been most carefully revised and considerably enlarged.

Calendars, etc.—Very charming calendars for 1923 have reached us from the D. P. Battery Co., Ltd., of Bakewell, Derbyshire, and Messrs. Haslam and Stretton, of Cardiff. The former is, as usual, a beautiful illustration in colour reproducing an aero photo of the works and properties of the company, including the staff and workmen's cottages and recreation ground. It shows the River Wye, which runs through the famous Derbyshire dales and supplies the motor power to these extensive works, and is really a very handsome picture, which will adorn any office. The other is a well produced illustration in colour of "Eva," and if the aforesaid young lady is a specimen of the types of female loveliness to be seen in the offices of Messrs. H. and S. we have no doubt that they will have a very large number of callers. Of course, ostentatiously on business, but possibly with an eye to other and more attractive objects.——From Mr. J. Martin Blair, M.I.E.E., of Amberley House, Norfolk Street, London, W.C.2, who is the representative in this country of the Hengelosche Electrische en Mechanische Apparaten-Fabriek at Hengelo (Holland), we have received a copy of the Company's Diary for 1923, and as it is a neat and convenient size for the pocket it is certain to be appreciated by all who are fortunate enough to receive it. In this instance the usual technical data has been omitted, but in place thereof a few illustrations are included of the very extensive range of the company's manufactures, such as A.C. motors and generators, switchgear rectifiers, etc. Mr. Blair will be pleased to send a copy of the diary to any electrical engineer who is directly interested.

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Sale Bargains.—Some small power motors and also some resistance wires are offered at bargain prices in our small advertisement page, to which we would refer our readers.

Johannesburg.—The Municipal Council invite tenders for tramcar spares (Contract No. 9). Specification and general conditions of tender may be inspected at the D.O.T. (Room 49), 35, Old Queen Street, London, S.W. 1.

Tenders Invited.—The P.M.G.'s Department, Sydney, New South Wales, invites tenders for telegraph and telephone instruments and switchboard parts under Schedule No. 944, and also for telephone and switchboard parts under Schedule No. 937. Particulars from Department of Overseas Trade, 35, Old Queen Street, London, S.W.1.

Trade Opportunities.—According to the current issue of the *Board of Trade Journal*, German electrical goods are again making their appearance in Peru. In Cuba the market for electric elevators and electrical goods generally is well worth cultivating. It is to be hoped that British manufacturers will do their best to hold their own in both these countries.

Reason Meters.—Central-station engineers, installation contractors and other trade users of these well-known meters will have every "reason" to be pleased with the very useful pocket knife which the company is presenting to its clients. It is strongly made, with two good blades and a 3-in. Chesterman steel rule showing English and metric measurements. Quite an acceptable gift.

Obituary.—At the funeral of Sir John Gavey, C.B., last Friday, at Hampton Wick, the Council of the Institution of Electrical Engineers, of which the deceased was a Past-President, was represented by Mr. F. Gill (President) and Mr. P. F. Rowell (Secretary), as well as by several other Past-Presidents and members of Council, together with numerous members of the Institution who were intimate friends.

Meetings.—The Junior Inst. of Engineers will meet at 39, Victoria Street, Westminster, S.W.1, on Friday, 12th inst. Paper, "Transient Phenomena Arising in Transformers from Switching Operations," by S. A. Stigant; also on Friday, 19th, lecturette, "Laminated Springs," by T. H. Sanders; on Friday, 26th, lecturette, "K.V.A. and its Measurement" (Demonstrations), by G. F. Shotter; and on Friday, 2nd February, lecturette, "Ventilation and Lighting of Factories" (slides), by P. J. Waldram. All at 7.30 p.m.——The next meeting of the Birmingham and District Electric Club will be held on Saturday, 13th inst., at 7 o'clock, at the Grand Hotel, Colmore Row. It is the first of a new session, and the President, Mr. C. G. A. McDonald, will deliver his inaugural address.

A Useful Rule.—We have received from the Sterling Varnish Co., Ltd., of 196, Deansgate, Manchester, an exceedingly useful steel folding pocket foot rule. It is of the best Chesterman make and marked in inches and centimetres, with subordinate fractions thereof, and we are confident that it will be much appreciated by the company's numerous clients in this country, to whom it will serve as a lasting reminder of the varnishes and other specialities for which they hold such a high reputation. It is enclosed in a neat leatherette case, with the company's name stamped thereon, and is altogether an exceedingly acceptable gift. Trade users of varnish should write the company on the subject.

The Electric House.—In connection with a series of competitions which it is inaugurating, the *Electrician* last week published the plans of a typical middle-class house, and is asking its readers to submit a wiring scheme which will permit all the ordinary domestic operations in it to be performed electrically. The last date upon which schemes can be received is March 29, 1923, and prizes of 25 guineas, 15 guineas and £5 are offered. The provision of a sufficient number of outlets for the use of electrical apparatus is a question to which architects, builders and others must give close consideration in the future. The competition should produce some interesting and useful ideas for the solution of this important problem.

Jigs and Tools.—On Thursday, 4th inst., a most interesting paper on this subject was read before the Inst. of Production Engineers, at a meeting held at the Engineers' Club. Mr. Fisher, the Vice-President of the Institution, occupied the chair, and he was supported by quite a large number of members and others to whom the paper made a direct appeal. It was written by Mr. J. Moore, chief jig and tool draughtsman of the Associated Equipment Co., of Walthamstow, and well illustrated with lantern slides, with the natural result that it was followed by a most animated discussion as it was of interest to such a wide circle of engineers. Practical papers of this nature are of great educational value in the trade, and are likely to aid very materially in reducing production costs.

Trade Notes.

Messrs. Todman, Ryall and Co., Ltd., engineers, of 38, Grosvenor Gardens, London, S.W. 1, have recently made considerable extensions to their business, and are now able to supply generators, motors, alternators and transformers of all sizes from ⅛ h.p. upwards. Their new catalogue will shortly be available, and they will be pleased to send a copy on application.

The "G. and P." Electrical Co., manufacturing electrical engineers, of 29, Heathcote Street, Nottingham, have opened a new branch shop and saleroom at 194, Great Alfred Street, Central Nottingham, and have appointed Mr. A. A. Brown as manager, and he will be pleased to receive old and new clients. The company are carrying very large stocks of electric cables, accessories, conduit fittings, etc.

The latest publication to be issued by **Bruce Peebles and Co., Ltd.** (Edinburgh), is a 24-page quarto pamphlet—No. 18c—giving a quantity of information regarding the company's standard open-type dynamos and motors. Most of the illustrations are new, and tables giving approximate weights and dimensions in the British and metric systems, as well as ratings and other technical data, are embodied. There is also a long list embracing some of the most important customers at home and abroad for the class of machines dealt with, though it must be remembered that the firm make all kinds of dynamo-electric machinery, particulars of which are available in other pamphlets.

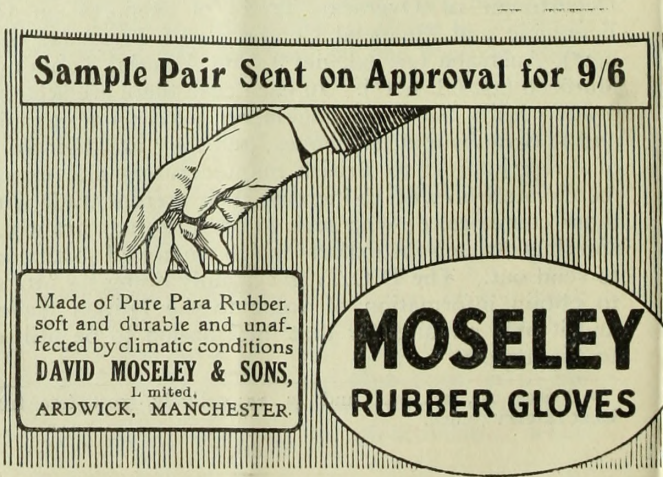
The **G.E.C.** have available for distribution booklets giving the reduced prices now ruling for their "Magnet" electric fires and electric cooking appliances. The booklets are numbered H 2,831 and H 2,860 respectively.

Dealers in Siemens' lamps and Siemens' supplies generally throughout the United Kingdom will be interested in the announcement that the lamp works of **Siemens Bros. and Co., Ltd.**, at Dalston, and of the **English Electric Co., Ltd.**, at Preston, have been transferred to the English Electric and Siemens' Supplies, Ltd., and further that the name of the latter company has been changed to the **Siemens and English Electric Lamp Co., Ltd.** The sale of electric lamps and various supplies will be carried on from 38-39, Upper Thames Street, London, E.C. 4, and from the company's various branches as heretofore, while no effort will be spared to maintain the high reputation for quality and service which has already been established.

NEW BOOKS PUBLISHED.

"20th Century Cookery," by Mrs. A. Mole, M.C.A. Demy 8vo, 40 pp., 1s. net.

"Pitman's Radio Year-Book, 1923," Cr. 8vo, 148 pp., illustrated, 1s. 6d. net.



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A POPULAR SCIENTIFIC WEEKLY JOURNAL
ELECTRICITY
A PRACTICAL TRADE JOURNAL

JANUARY 19, 1923.

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METHODS OF DEALING WITH PEAK LOADS.

During the past twenty years the nature of the load curves of electricity stations has been radically altered. At the beginning of this century the main load on practically all stations was confined to a few hours in the evening, the consumption of electrical energy being mainly for lighting purposes. At the present time, on the other hand, industrial power represents the main load in the majority of stations and, due to this fact and the higher efficiency of metal filament lamps (compared with the carbon filament type), the lighting peak is relatively small and in some cases considerably lower than the load during the working hours of factories. An example of this is shown in Fig. 1, reproduced from a recent issue of the *Technische Rundschau*. The curve *a* is the load curve of a typical day in the

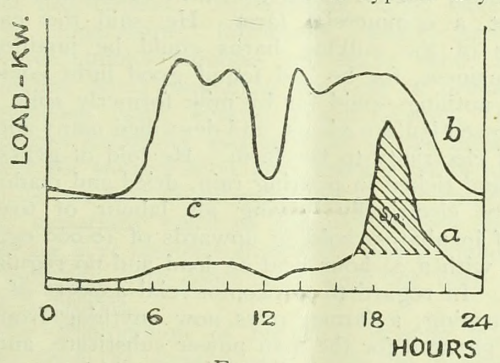


FIG. 1.

winter of 1904-5, whilst the curve *b* is the corresponding record for a day in the winter of 1919-20. The shaded area represents the peak load under the old conditions, and it will be seen that the minimum load under present conditions is far higher than in the old days; also, there is a nearly uniform load of the station during the morning and afternoon.

The lighting peak of 20 years ago was almost invariably supplied by means of a storage battery. Taken over the full 24 hours, there are still peak loads to be dealt with, but these are no longer of short duration, but consist rather in the excess of the day load over the minimum load (*c*, Fig. 1), the latter being the night load built up by demands for electro-chemical purposes, electric furnaces, battery charging, etc.

The use of storage batteries for dealing with peak loads is now limited by the fact that most modern stations are three-phase installations; also, the output required during the peak period is so great that very large batteries are needed. Nevertheless there is still a distinct field of utility for storage batteries in connection with direct current networks, including tramway systems, especially where sufficient energy is available at low prices during the night to recharge the cells. The depreciation and capital charges of the battery and the energy losses therein must be taken into consideration, and if the overall costs are to be reasonably low, the energy used to charge the cells must be available at a very low price.

An alternative method of storing surplus energy available during the night for use during peak load periods consists in the use of an electrically driven pump to raise water to a storage basin above the station, when water flows to drive a water turbine and generator when the output required exceeds the capacity of the main generators. The practicability of this system of working presupposes the possibility of constructing a storage basin at reasonable cost. If there is also a storage basin for the tail water, the system can be worked without any serious consumption of water, the amount used being only that required to make up for evaporation, etc., the main body of water being circulated continuously between the two basins.

The minimum load *c*, Fig. 1, is supplied in all large stations by turbo-generators which run continuously, day and night, for months on end. Under these conditions the turbines operate with very high efficiency and the difficulties and risks associated with frequent warming up and putting out of commission are avoided. The basic load may, alteratively, be supplied by Diesel or gas engines, where fuel oil is cheap or where coke oven gas or blast furnace gas is available

In either of these cases, the peak demand may be supplied by more or less obsolete generating plant, which is idle except during the peak periods, when its relatively low efficiency is of minor importance compared with the service rendered in carrying the peak load without requiring fresh capital investment.

If the basic load *c*, Fig. 1, be supplied by a hydro-electric station, it will generally be cheaper to supply the peak load by auxiliary steam plants or by Diesel- or gas-engine driven generators. The reason for this is that the capital investment in water power plants is generally high, so that it becomes prohibitively expensive to supply short-hour demands by this means. In some cases, of course, the natural conditions are such that water power can be developed by relatively small exenditure upon the hydraulic equipment, and it may then be profitable to use water power for the peak load as well as for the steady demand.

Referring to Fig. 2, the curve W represents the water available in a low-pressure hydro-electric installation during 360 days. Of this, the energy represented by the area F_1 is utilised by the basic load on the system, the peak load plant supplying energy repre-

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sented by the area F_2 during half the year in order to compensate for the inadequacy of the water supply during this period. During the first half of the year there is, in the case illustrated, surplus water power represented by the area F_3, and this might as well be used for serving peak load demands.

Under the conditions represented by Fig. 3, the

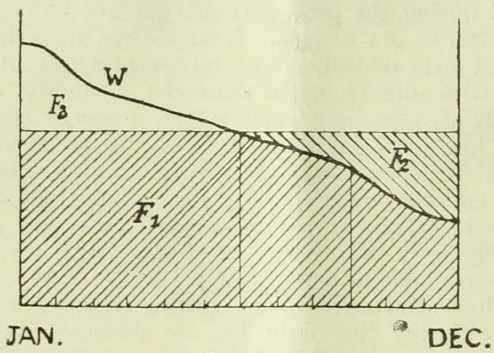


FIG. 2.

inflow of water is represented by the curve *z* and is a maximum during the summer owing to the melting of mountain snow. On the other hand, the demand for energy is represented by the curve *a*, which is at its maximum during the winter. The only method of reconciling these two curves is by providing water storage facilities; this may or may not be economically practicable. With fuel costs at their present high level, there are more cases than ever before in which it is profitable to develop water power.

The great progress in high tension electrical engineering practice has made it possible to interconnect water power and coal power stations which are separated by 100 or 200 miles, or even greater distances. The water power station then supplies the

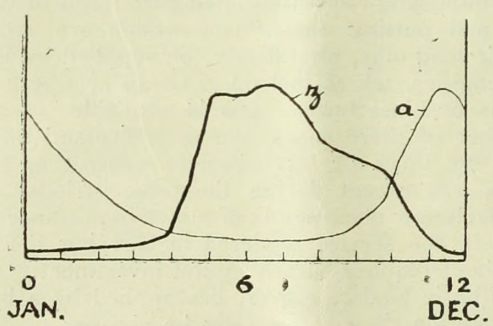


FIG. 3.

whole system to the maximum of its capacity at all times, the coal-fired station taking over the load when the water power available is inadequate. Apart from the inherent advantage of using water power rather than coal it will be seen that this method of working virtually replaces the transport of coal for power purposes by the more convenient and economical transmission of electrical energy. The cost and inconvenience of congesting railways with coal traffic is avoided by transmitting energy in electrical form by overhead lines which, incidentally, can be tapped for power at any point throughout their length. By means of static transformers and, if necessary, frequency changers, electric transmission systems of different characteristics can be interconnected for purposes of parallel operation, but it is, of course, much preferable that the frequency should be the same in all the systems concerned. Voltage transformation involves no particular difficulty or expense, but the same cannot yet he said where frequency changing is concerned.

AN ELECTRIC INSTALLATION AT A MODEL FARM.

At the meeting of the Informal Section of the I.E.E. on Monday, December 4th, Mr. F. A. Sclater opened a discussion on "An Electric Installation at a Model Farm." Mr. Sclater commenced by saying he did not propose to speak of electrical farming, but to describe a plant he had installed some two years ago in the dairy farming quarters of a large estate in the South of England.

His paper was of very considerable interest, and his lantern slides, showing the scrupulous cleanliness of the milking and feeding barns, with paved and covered approaches, the absence of mud usually associated with farms, and the studied convenience of the lighting with its two-way controls were admirable.

Notable, too, was an ingenious and rapid self-starting device (Sclater's Patent) for the 17-h.p. engine —by motoring the generator from the storage battery and drawing to the engine waste heat from the regulator coils.

Mr. J. F. Avila was in the chair, and in announcing the discussion open he appealed specially to diffident members to make an effort to express their views. He said the opening paper was intended as a lead for subsequent remarks, not as a treatise to be formally deliberated upon. As Mr. R. Borlase Matthews was present, he asked him to speak and to extend the range of the discussion by describing instances of electricity applied to agriculture.

Mr. Borlase Matthews congratulated Mr. Sclater on his success, but criticised the farm as being a model and not a commercial farm. He said the careful lighting of the milking barns could be justified as good business, for he had found good light could be got for nothing—paid for by milk formerly spilt. He also showed lantern views, and described many applications of electricity to the farm. He told of grass cut, carted and ricked in pouring rain, dried and made into *real hay* electrically—saving all labour of tossing. Then of incubators holding upwards of 10,000 eggs at a time, with a 24-hour heating load and no regulating trouble. In regard to the commercial aspects of electrical farming, a farmer pays now anything from 5s. to 15s. per unit for the man power substitute, and the capital outlay for electrical machines could be recovered in three years. The paternal German Government is so alive to the importance of this subject that South German farmers have been notified that they must avail themselves of electrical methods within the next three years or vacate their farms. He also announced that the British authorities had just agreed to broadcast weather reports by wireless telephone instead of the ten-words-a-minute Morse system now employed.

Mr. Young asked for information regarding the regulations governing the crossing of lanes and roads when linking isolated buildings on a farm.

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Mr. C. T. Walrond suggested the use of a steam plant as a prime mover, so as to combine the laundry and the pasteurising plant in the dairy.

Mr. P. Dunsheath thought the care for cleanliness in the farm described made for good reputation, which is *not* uncommercial.

Mr. F. Pooley, who had seen the farm described, testified to the skilful way the installation had been carried out, and to the severe tests under the scouring with water that some barns received twice daily in the zeal for cleanliness. He thought that until agricultural electric machines were specially designed some speed reduction device was necessary.

Mr. W. L. Wreford exhibited a compact gear (H.R. Gear), giving straight through drive and almost any desired speed ratio, as very applicable to farm use.

Mr. H. W. Richardson spoke of the enormous load agriculture holds in prospect, and he compared some of the attempts to reach this huge prospect.

Mr. J. F. Avila, J. R. Bedford, E. B. Rook, J. F. Caine, B. Challis, J. Coxon, A. H. Dixon-Dykes, Col. E. A. Edwards, A. G. Hilling, W. E. Rogers, W. J. Minton, and W. E. Warrilow also spoke.

In reply to the vote of thanks for his opening paper, Mr. Sclater remarked that he as an engineer had applied his best to the farm needs; but Mr. Borlase Matthews, as a farmer and engineer, was able to speak the farmer's mind, and that was what all engineers had to study.

ELECTRICITY IN TEXTILE MILLS.

Addressing a recent meeting of the Blackburn Textile Society on the subject of "The Future of Electricity in Textile Mills," Mr. P. P. Wheelwright, M.I.E.E., electrical engineer to the Blackburn Corporation, said that in working out total power costs one often lost sight of cost of time and material in plant maintenance, depreciation, rates, taxes, insurance, supervision, lubricants, water, stores, ash removal, smoke troubles and many other incidental expenses, when comparing the cost of private power installation with central power supply. In other countries electricity was accepted as the most efficient power for transmission and distribution in all trades, and he felt that its extended use in this country would very materially assist to obtain increased production, meet the ever keener competition, and stimulate revival in industry, with continuous work for both employer and employed.

The introduction of electrical driving into textile mills could be accomplished with the minimum stoppage of plant and work, and, when one considered the installation of modern machinery in up-to-date concerns, it was difficult to understand why the actual manufacture of the power required to drive such plant should be so much overlooked. It must be acknowledged that the electrification of all mills, works, etc., benefited not only the owners and workpeople, but the town where the works were situated, as well as the nation at large, by the conservation of coal which, as the war taught them, was one of the country's greatest assets.

The power required to drive an electrically driven textile factory, either on the group or individual system, was very much less than in the case of the steam-driven factories. Cases were on record where the losses due to friction, etc., in mechanical transmission, when operating under full-load conditions, amounted to as much as 40 per cent., which was traceable to heavy shafting, defective gearing, cross drives, belts, etc. This loss was continuous every minute the mill was in operation, and still went on whether much or little machinery was running, so that the efficiency dropped rapidly as the load fell off. This was not the case with electrical transmission, and in individual driving the efficiency remained fairly constant, as the power required was in proportion to the number of motors in operation. Moreover, electrical driving offered advantages which could not be measured in financial terms.

So far as textile mills were concerned, electrical usage resulted in constant speed and steady drive, and increased production as a consequence. Without actual tests it was difficult to convince people that with the ordinary mechanical transmission serious fluctuations in speed occurred, and that these affected production and quality. Moreover, speed fluctuations grew worse as the distance from the source of supply increased. Actual tests showed that a 3 per cent. variation in engine speed resulted in a 20 per cent. variation in the line shafting, whereas with well-arranged group driving the variation on loom line shaft might average 5 or 6 per cent. of the mean speed.

With the individual drive the loom average came down to 2 per cent. of the mean speed. Also, the advantages of constant and increased speed in the driving of a textile mill could not be too highly emphasised, as a small percentage increase of the total revenue obtained by any fair-sized manufacturing concern would cover many times the increased driving cost, which, in most mills, was a small percentage of the total manufacturing costs. Improved quality of material resultant on a steady drive would also attract a higher price, or would sell better in a given market. Moreover, the speeds of mechanically driven looms could be increased when electrically group driven, and further increase might be made when individual electrical driving was adopted.

Mr. Wheelwright went on to deal with the expense, inconvenience and difficulties of individual electric plants in industry, and said power purchased from a central authority relieved the owner and manager of a thousand and one details and worries. In sectional and departmental working considerable economies could be effected with a good lay-out and well-arranged electrical drive, by shutting down departments or sections not in use, and then running the remaining ones at full load and efficiency. It was of the greatest importance that measurements of electrical energy absorbed should be taken at regular intervals, thereby affording continuous indication of the state of the machinery and the amount of work obtained therefrom. In this way a manufacturer was able to calculate the varying power required, and its cost, when working on different classes of material. Another advantage was the fact that electricity afforded more effective and natural lighting by the reduction of shafting and belting, and only a lighter building construction was neces-

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sary, thus providing greater safety, more cleanliness and greater comfort and health to the workers. In the case of mills requiring new machinery, these alterations were rendered more easy and expeditious by the use of electric motors, with practically no stoppage of working. Mr. Wheelwright also referred to the easier method of heating by electricity, and its economical aspect. The speaker went on to deal with the respective advantages of individual driving of looms, mules, ring frames, etc.; group driving with large motors to replace the mill engine by one large motor; and group driving with small motors, specially adapted for old mills. The cost per unit was not the only factor to consider. Our natural temperament was against repeated or rapid changes, whereas, in the States, possibly the other extreme was reached. Nevertheless, after a period of war, when industrial progress was at a standstill, the loss would have to be made up. English power charges compared most favourably with those of other countries. There appeared to be no shadow of doubt that the day of the use of electricity for every purpose was very rapidly approaching, and was a natural process. In the textile trade the electrification of mills in Lancashire had made nothing like the headway of the Colonies and of India, where it was the rule rather than the exception to find mills electrically driven. These people were competitors, and their adoption of electricity was based largely on their knowledge and experience of its commercial and economic supremacy.

"BUSINESS EFFICENCY."

The forthcoming "Business Efficiency" will take place at the Central Hall, Westminster, from February 7 to 17 next, and will be officially opened by Mr. Neville Chamberlain, M.P., Postmaster-General, on February 7, at 12 o'clock.

THE FORTHCOMING "BUSINESS EFFICIENCY."

Now that, according to the highest authorities, trade is on the turn, and there are unmistakable signs in every direction that such is the case, business men all over the country will welcome the unique opportunity provided by "Business Efficiency" for witnessing all the latest scientific and labour-saving devices for facilitating business.

The aim of "Business Efficiency" is to demonstrate how one man, with the aid of modern office appliances, can do the work of ten, how maximum efficiency can be secured at minimum cost, without interfering with existing organisations, and how by the introduction of better methods success can be established to the utmost degree.

As "Business Efficiency" was so successful in this direction last year, it was decided to continue it again on a far more extensive scale. Consequently more than double the accommodation has been reserved for this year's effort.

It will show how a far greater turnover can be secured for every individual firm, how the costs of production can be lowered in both office and works, and how future dividends can be paid out of savings. This is the psychological moment, when British trade is reviving, for business firms to take advantage of every possible appliance which will speed up production in every department.

The exhibits will include the very latest telephone system, by means of which two persons in different parts of an extensive building can speak to each other from whatever part of the room in which they happen to be without the necessity of raising the mouthpiece. This alone is a marvellous invention—worth going to see.

Another amazing example of efficiency, among the many which will be shown, is the latest calculating machine. In an instant, by a shuffle of the index cards, answers to every conceivable question relating to the customer can be obtained. Yet a further innovation is the complete office printer, which can be operated by junior clerks, and turns out every description of printing quickly at 50 per cent. less cost. It is certain to interest go-ahead employers in the electrical industry.

THE CIRCLE OF SCIENTIFIC, TECHNICAL AND TRADE JOURNALISTS.

This Circle has now completely resumed its normal activities, and the annual meeting held on January 9 was an interesting event. The meeting was preceded by a dinner in the Hall of the Institute of Journalists, and there was a representative gathering of editors and members of the technical Press.

Mr. Leon Gaster, who presided, recalled some of the chief activities of the Circle since July, 1914, when he assumed the chairmanship and expressed the hope that it would have a prosperous future. Several recent visits of interest, notably to the new showrooms and laboratories of Holophane, Ltd., and the L.G.O. repair shops at Chiswick, have been noticed in ELECTRICITY. Mr. Gaster is now relinquishing the chairmanship after eight years of useful service, but he will continue to assist the Circle as hon. secretary, and will have the help of two hon. assistant secretaries, Mr. Percy L. Marks, who will deal with papers and discussions, and Mr. P. N. Hasluck, who will supervise arrangements for visits and social events. The new chairman, Sir Richard Gregory, has not only a long experience of technical journalism, but is familiar with many branches of science. The new vice-chairman is Mr. A. C. Meyjes.

At the conclusion of formal business, Sir Richard Gregory gave a delightful address on "Reviews and Reviewers," and this led to an interesting discussion. The problems of an editor are numerous. He must decide which of the many books offered him for review he can adequately deal with. He must select appropriate reviewers, bearing in mind his duty to readers of the journal. Most of those joining in the discussion agreed that highly specialised works should be submitted to an expert in the subject. But he must have a judicial mind, neither hypercritical on the one hand, nor too generous on the other. An interesting point is whether reviews should be signed or unsigned. In some special cases the author may consent to append his signature, but in most cases reviews are best anonymous.

British Empire Exhibition.—Owing to the demand for space for the engineering and electrical exhibits, it has been found necessary to arrange for the extension of the Machinery Hall by upwards of 70,000 square feet.

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VARIABLE SPEED A.C. MOTORS WITHOUT COMMUTATORS.

At a recent meeting of the I.E.E., Mr. F. Creedy gave an interesting and instructive lecture on the above. The following is a summary of the matters dealt with, important as the polyphase A.C. system of supply will ultimately be adopted on a large scale for power purposes :—

After a short general discussion, a new method of pole-changing, involving the use of a number of phases greater than that in the line, was explained, together with means for simplifying the connections :—

(A) By the use of mutually reversed coils.

(B) By a star-mesh connection.

The phase transformer needed to produce the increased number of phases was next described, and it was shown that the current in the windings intermediate between the three-phase tapping points was reduced to a very low value as in the rotary converter, making the apparatus small and inexpensive.

The switchgear employed was next discussed, and it was pointed out that the methods described rendered the squirrel-cage motor adaptable to almost all purposes, since they enabled it to give good starting torque with low current.

Machines with slip-ring characteristics were also described and test results discussed.

A description was given of the cascade motor, and its unique characteristic of giving gradual adjustment between speeds were explained. Two-, three- and four-speed motors having this characteristic were referred to.

Some tests of large rolling-mill and other motors were given, and finally a description of the application of the cascade motor as a short-circuit motor machine with slip-ring characteristics, and as a unity-power-factor synchronous machine of greater simplicity and less cost than any other type.

Meetings.—The Junior Inst. of Engineers will meet at 39, Victoria Street, Westminster, S.W.1, on Friday, 19th inst., lecturette, "Laminated Springs," by T. H. Sanders; also on Friday, 26th, lecturette, "K.V.A. and its Measurement" (demonstrations), by G. F. Shotter; and on Friday, February 2, lecturette, "Ventilation and Lighting of Factories" (slides), by P. J. Waldram. All at 7.30 p.m.

Preston.—At the Corporation tramways office last Sunday there was an official farewell to Mr. J. F. Simpson, former engineer and manager, who, by accepting the managership of the electrical undertaking, severs 17 years' continuous connection with the department. His successor, Mr. H. Clayton, expressed the hope on behalf of the men that Mr. Simpson would meet with success in his new sphere. Councillor J. Woolley, J.P., chairman of the Tramways Committee, then presented Mr. Simpson with a cheque as a farewell gift, after which Mr. Simpson responded, and said his new department would, he believed, prove a great asset to the town.

Electricity Commission.—The Commissioners give notice that they will hold a local inquiry at the Town Hall, Preston, on Tuesday, February 20, 1923, at 10.30 a.m. and following days, with reference to the area to be included in the proposed Mid-Lancashire electricity district, and to consider (*a*) a scheme which has been submitted jointly by the Corporations of Blackburn and Preston for effecting an improvement of the existing organisation for the supply of electricity in the said district and for the formation of a Joint Electricity Authority, and (*b*) a scheme which has been submitted by the North-East Lancashire Electricity Committee for effecting an improvement of the existing organisation for the supply of electricity in the said district, and for the formation of an Electricity Board.

BIRMINGHAM AND DISTRICT ELECTRIC CLUB.

At the opening meeting of the new session on Saturday, January 13, the president, Mr. C. G. A. McDonald, delivered his presidential address, which he entitled "Stocktaking."

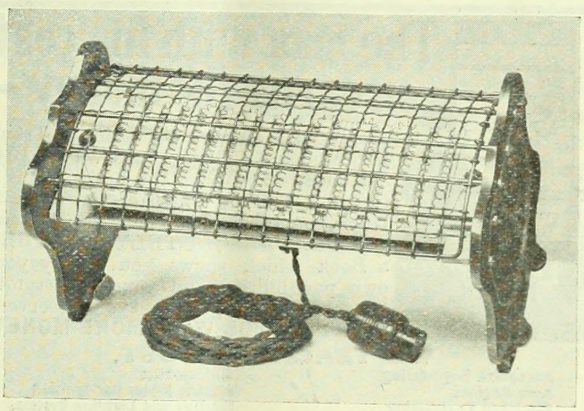
A large portion of the address dealt with the shortcomings and lost opportunities of the committee in charge of the Birmingham Electricity Dept., which had brought Birmingham to a very low position in electrical development. Generation costs were higher and consumption less per head than in other cities of equal rank.

Mr. McDonald stated that it was essential for everyone interested in the industry to stimulate the enterprise of the City Fathers, so that Birmingham might take a position more in accord with its past history and future destiny.

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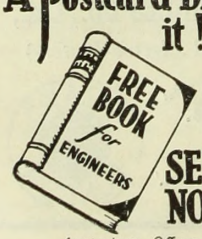
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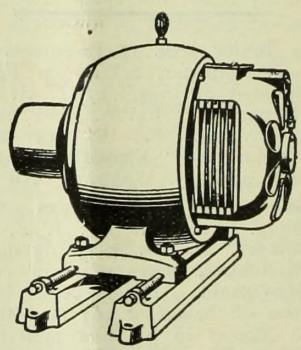
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TO OUR READERS.

ELECTRICITY is published every Friday, and, if ordered, is on sale at the principal Railway Station Bookstalls and Newsagents on that day. It has a very large sale throughout the United Kingdom, as well as in the British Colonies and Abroad.

Questions to which an answer is required must be accompanied by a 1½d. stamp for reply. When considered of sufficient interest, the answer will probably appear in the paper.

New advertisements for the displayed columns and alterations to existing ones must reach the publishing office not later than first post Tuesday morning, in order to be in time for the issue of the following Friday. This is important. Rate quoted on application. Subscription: 13s. a year, 6s. 6d. half year, 3s. 3s. a quarter in advance, postage prepaid in the United Kingdom and abroad.

All remittances payable to the Publishers, S. RENTELL AND CO., LTD., 36-39, Maiden Lane, London, W.C.2. Telephone No. 2460 Gerrard.

Current Topics.

Trolley-'bus v. Petrol Motor-Omnibus.

In view of the rapid and enormous development of the motor omnibus it is rather surprising that so little attention has been paid to the possibilities of the trolley-'bus or railless traction system. Mr. Taff's recent paper on the subject of Railless Trolley Traction read before the Institution of Automobile Engineers is therefore opportune, especially as he presents illuminating data regarding the relative capital costs, working costs, and economic revenues of tramways, motor omnibuses, and trolley 'buses respectively. As Mr. Taff observes, the adoption of any system of transport depends upon two main factors, viz., its utility and financial soundness. The latter factor is vested in a satisfactory compromise between low first cost and low working expenses. Taking a hypothetical case, that of serving the inhabitants of 600 houses on a site about three miles distant from the centre of the township, he shows the capital cost of tramways to be three times that of motor omnibuses, and over twice that of a trolley-'bus system.

In standing charges also the tramways show to great disadvantage, the total for this system being just under double that of both the alternative systems. In total working costs the tramway shows a slight advantage at 11.6d. per car mile, over the motor-omnibus at 18.0d., and the trolley-'bus at 12.0d. per car mile respectively. A combination of the two sets of statistics revealed a lower economic revenue to the advantage of the trolley-'bus, which would only have to earn £18,430 as against nearly £33,000 for the motor-omnibus and just under £22,000 for the tramway. The comparative economic fares would be for the tramway, 1.72d.; for the motor-omnibus, 1.84d.; and for the trolley-'bus, only 1.37d. per passenger mile, another point in favour of the trolley-'bus system. The author agreed that traffic requirements in the matter of density, frequency, etc., also entered into the decision as to which method of transport to adopt in any particular case, but adduced other advantages which, in the aggregate, constitute a very good case for the trolley-'bus, and should give transport authorities and municipalities furiously to think.

Professional v. Amateur.

The recent achievement of the members of the Radio Society of Great Britain in signalling across the Atlantic on a wave length of only 200 metres and a maximum power of 1½ kilowatts, to which I referred in my notes last week, has prompted the leading wireless company to offer some explanation of its policy in regard to enormous wave lengths and huge power stations for commercial Transatlantic wireless telegraphy. In an interview with a *Times* representative Mr. Marconi paid a tribute to the success of these amateur efforts, but discounted the value of their results viewed from a commercial standpoint. He pointed out that the tests were conducted at a period particularly favourable to transoceanic wireless, and stated that he had himself proved by personal experiments, conducted over twenty years ago, that the short wave length was not reliable at all times of the year and for such long distances.

With all due deference to Mr. Marconi, the facts remain that diligent British radio amateurs have scored a point in successful Transatlantic wireless telegraphy on short wave lengths and at low powers; that they are also daily making further progress in transoceanic wireless telephony, again with small powers and limited wave lengths; that twenty years is a long time in the history of wireless progress; that there is very considerable difference between wave lengths of 200 and 35,000 metres and powers of 1½ and 350 kilowatts; all of which prompt the reflection that the efficient Empire Wireless Chain of the future may not, after all, call for the erection of huge and complicated antennæ, and the installation of what amount to moderate sized power stations at all transmitting centres.

Broadcasting Asides.

I offer a well-intentioned hint to the several operators and artistes who daily minister to our "listening-in" appetites at the main transmitting stations of the British Broadcasting Company, and it is that they will have to exercise discretion in regard to conversation in the various studios which is not intended to be broadcasted. Listening-in to Manchester the other afternoon on a particularly efficient set, I heard through the loud speaker a low hum of conversation which took place between the operator and someone else close by, in between turns during the three minutes we had been asked to "stand by." As sensitiveness increases, and the apparatus improves, I foresee that rules enforcing silence in the transmitting studio will become the order of the day.

Whilst on this topical subject there is another factor which is going to exercise rather a distracting influence over successful listening-in, viz., electric tramways and power transmission and distributing systems. The non-success of many demonstrating sets as installed in business premises where broadcasting apparatus is sold, and which are usually located at or near the centre of towns where tramways abound or electric lights and motors immediately surround the premises, is due in large measure to this interference, and those who have the interests of the new pastime at heart might well devote their energies to discovering an antidote or, at all events, a palliative. I visited a "listening-in" parlour the other day, located in a busy city thoroughfare, and the reproduction, although perfect so far as it went, was hopelessly marred by obvious tramway induction noises. Who is going to be the first to solve the problem of an effective filter, amateur or professional?

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Electricity Breakdowns.

Now that failures in supply are becoming so alarmingly frequent throughout the country, it is opportune to raise the question whether these occurrences should not form the subject of an official inquiry by some competent authority. In the case of a railway accident the Transport Ministry intervene and seek to discover the cause, with a view to future prevention of similar occurrences. When a colliery accident is reported it is similarly the duty of the Home Office to inquire into it, and, if necessary, penalise the delinquents. True, both these forms of procedure are intended primarily for the preservation of human lives; but public convenience is also a matter of common interest, to say nothing of the reputation of the industry of electricity supply. A competent authority already exists in the Electricity Commissioners, and it would appear desirable in the interests of the vast numbers of power consumers to institute some form of official inquiry, such as I have indicated, even if only as a salutary check on what would too often appear to be culpable negligence or inefficiency in the organisation of supply undertakings. The electricity supply industry is not yet so firmly established in this country that it can afford to flout public opinion, and official supervision would be a healthy incentive to efficiency.

Reduced Rates per Unit.

Congratulations to Rotherham upon the progressive policy of its Electric Light Committee, which, in spite of an aggregate loss during the past three years of no less than £50,000 on the undertaking, has resolved to reduce the charges to consumers to the extent of 15 per cent. on the war-time advance, representing a substantial concession to power users, .2d. less per unit for traction, and 2d. per unit less for current supplied to cinemas. Based on present demand, this reduction represents an estimated loss of revenue of £30,000; but it is safe to assume that the greater encouragement thereby offered to the department's clients, and local power users in particular, will result in a gratifying increase in the demand for energy, lead to increased employment in the factories taking power, and ultimately recoup the committee for its bold policy.

ELEKTRON.

SIR JOHN GAVEY.

One of the pioneers of telegraphic communication has passed away in the person of Sir John Gavey, who died at Hampton Wick in his 80th year. It is 62 years since he entered the service of the Electric and International Telegraph Co., one of the companies which worked the telegraphs before they were taken over by the Post Office. Then, in 1870, he joined the G.P.O. staff, in which he rose to the highest position. He was successively: Electrical Superintendent of a Division; Superintendent Engineer, Wales Division; Chief Technical Officer, G.P.O.; Assistant Engineer-in-Chief; Engineer-in-Chief; Consulting Engineer to G.P.O. After 53 years of work in his profession, Sir John retired in 1913. The developments of the telegraph, the telephone, and of wireless in this country are largely due to his work. He installed the first trunk telephone wire in this country—between Cardiff and Newport—in 1881, and the first wireless telephone between the Skerries Lighthouse and Holyhead. Sir John introduced many improvements in the working of the Wheatstone transmitters, which had the effect of multiplying many times the speed at which telegrams could be despatched. The taking over of the telephones by the G.P.O. largely increased his responsibilities and work.

Questions and Answers by Practical Men.

RULES.

QUESTIONS: *We invite our readers to send us questions, preferably on technical problems that have arisen in actual practice. Questions which we consider of sufficient interest to our readers will either be replied to under "Answers to Correspondents" or replies will be invited from our readers. One shilling will be paid for the question which we select for competitive replies in this column.*

ANSWERS: *A fee of 10s. will be paid for the answer which we consider shows the greatest merit, and 5s. for the one we select as second best. In judging the replies, importance will be attached to clearness and conciseness, as well as accuracy. The Editor reserves the right to make no award, or to accept only one reply, if, in his opinion, the answers received do not possess sufficient merit. Competitors desiring the return of their manuscripts, if unaccepted, should enclose stamped addressed envelope.*

Write on one side of the paper only, and if diagrams are sent, draw them on a separate sheet of paper attached to the manuscript. Competitors may adopt a "nom de plume," but, both in the case of questions and answers, the competitor's real name and address must be sent with the manuscript as a guarantee of good faith. No correspondence will be entered into with regard to successful replies. The Editor's decision is final.

Commencing with Question No. 101, a Diploma of Merit will be awarded to the six competitors who win the first or second prize the most times during the next twelve months.

The words "Questions and Answers" or "Q" and "A" should be placed at the top left-hand corner of all letters intended for this column.

QUESTION No. 153.

Is the old Marconi coherer suitable for wireless telephony receiving sets? Is so, how can I adapt it for this purpose?—"B.B."

QUESTION No. 154.

I have a new accumulator enclosed in a celluloid case. Its capacity is 50 ampere hours. I notice that sulphating has commenced to take place, not on the plates, but on the bars which hold the plates together. Is this injurious? If so, how can I prevent it?

—"PAX."

(Replies to Questions 153 and 154 must be received not later than February 10, 1923.)

Answers to Questions.

QUESTION No. 148.

I have a spare motor-starter 220 volts, 10 h.p. I use this in case of emergency to start any 10 h.p. motors. I would like to use this starter to start 20 h.p. motors as well, but I am told that considerable alterations to resistance will be necessary. I would like the benefit of the experience of your readers on this matter and I would appreciate any assistance that is offered.—"STARTER."

REPLIES TO QUESTION No. 148.

No satisfactory replies were received to this question owing, probably, to the paucity of the details given. We, however, in an effort to assist "Starter," submit the following details of our experience on this subject:—

We have known motor starters of a low horse-power to start motors of a much greater horse-power. It must be said, however, that the governing factor is the amount of load upon the motor at starting, and the "rating" of the starter.

Ignoring intermittent rating starters—which are designed to start motors over a minimum period of time—it may be said that manufacturers make con-

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tinuous rating starters which will carry the full load current of the motor over a definite period of time. The resistance wire, or grid, is of such cross sectional area that a predetermined temperature rise is not exceeded, that is, over this period.

Thus, a 10 h.p. motor starter may be wound with a resistance which will carry, say, 20 amperes for a half minute, but it is possible that this same resistance will carry quite 40 amperes for five seconds without the 10 h.p. predetermined temperature rise being exceeded. In this case, it may be said that, as long as the 40 amperes is not exceeded above a period of five seconds, and the motor is up to full speed in that time, the 10 h.p. starter may be considered satisfactory to start the 20 h.p. motor.

We remember one case quite well, where a 10 h.p. motor starter was used, in case of emergency, to start a motor of 50 h.p. connected to a generator. In this case the resistance had to carry much more current for about two seconds than it would have done if it had been used with a motor armature under full load conditions. This was because the resistance of the armature of the larger motor was less than that of a small one, and a considerable amount of resistance had to be cut out before full load current was passing through it.

For a motor starting a length of shafting it cannot be said to be under no load, although no machines may be connected to it. There is a considerable amount of weight in a length of shafting, and it is probable that full load current would be passing through the resistance of the starter over about half the predetermined period of time allowed for the complete starting of the motor under full load. In this case it is quite clear that a starter designed to start a 10 h.p. motor would not operate satisfactorily with a 20 h.p. motor. This is because the heating effect of the current would probably burn the resistance out.

From the above two cases "Starter" may be able to judge whether his resistance may have to be rewound. If so, then it should be wound with material which will carry the full load current without exceeding a temperature of 140 degrees for, say, fifteen seconds.

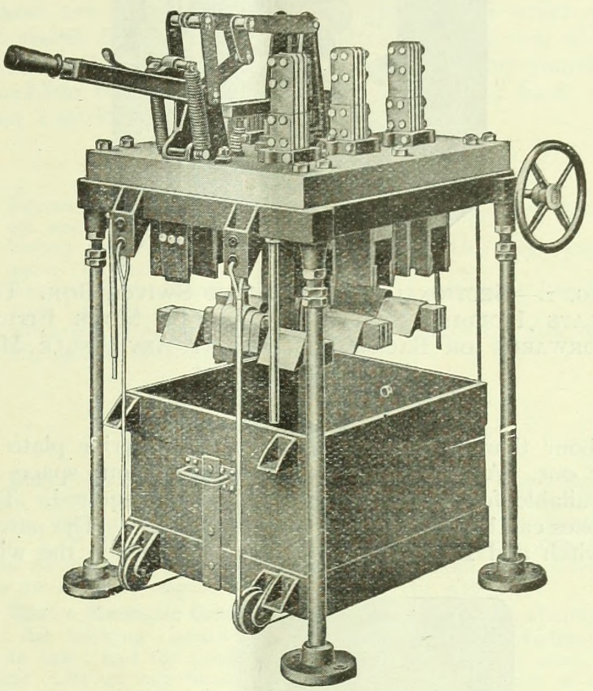
EDITOR "ELECTRICITY."

MODERN OIL SWITCHES.

Automatic oil switches have been manufactured by Johnson and Phillips, Ltd., since 1902, so that the present-day designs embody the results of over 20 years practical experience. The modern standard ratings, listed in a comprehensive J. and P. catalogue just recently revised, embrace all sizes up to 2,500 amps. per phase, three-phase, and 11,000 volts, and, although many refinements are now embodied, it is interesting to note that the original design, embodying as it did two breaks per phase with all phases in one tank, is that which out of the numerous and ingenious types developed has survived to this day and is now made as standard for ordinary breaking capacities by all present-day manufacturers.

The switches are arranged for direct operation, remote mechanical operation, or remote electrical operation, and the following combinations for trip-coils can be supplied:—One, two or three overload trips; shunt trips only; shunt trip with one, two or three overload trips; no-volt release only; no-volt release combined with one, two or three overload trips; no-volt release combined with shunt trip; no-volt release combined with shunt trip and one, two or three overload releases.

The accompanying illustration shows the O.S. 3 size J. and P. oil switch (for breaking up to 2,500 amps. at 650 volts). The slate base for the switch is supported on an iron framework and provides the insulation for the fixed contacts, the framework supporting the operating mechanism and oil tank. The supporting framework is arranged for mounting on the floor



behind the panel or in the cubicle. The mechanism is simple and robust, ensuring easy closing and rapid opening. The moving contacts are in all cases of the solid type, the fixed contacts of the laminated brush type, and the contact is made by a wiping, self-cleaning action. H.C. copper only is used.

The contacts and switch frame are designed to prevent heating due to the skin effects present in conductors of large section, and to eddy currents both in the conductors and in magnetic material in their proximity when heavy alternating currents are being carried. A feature of this switch is the provision of substantial arcing tips on both the fixed contacts, so arranged as to protect the main contacts from injury when opening under short circuits. Easy manipulation of the tank is provided for by means of a substantial tank lowering mechanism which forms an integral part of the switch. Further to assist handling, the tank is fitted with an oil gauge and a draw-off cock.

Sweden.—No. 4 of *Sweden Economic Review*, just received from the Swedish Consul-General, shows that trade and employment in that country are, on the whole, still in a depressed condition, but the outlook is decidedly more promising. The timber trade is certainly much better, the exports of iron ore are increasing, chemical plants are resuming work, and there is more employment in the electrical industry. In addition, railway rates are falling, and the Government is reducing its official expenses.

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A NEW SUNCO FLUSH SWITCH-BOX.

The Sunco switch-box, illustrated in Fig. 1, is so designed that perfect fitting is obtained between switch, switch-plate and wall, with the expenditure of no more

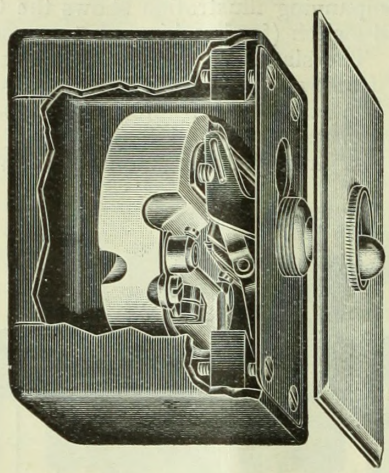


FIG. 1.—SECTIONAL VIEW OF SUNCO SWITCH BOX. THE PLATE HOLDING SWITCH IS FREE TO MOVE EITHER FORWARDS OR BACKWARDS, AND AT ANY ANGLE MET WITH IN PRACTICE.
(Scale two-thirds full size.)

labour than is required to screw the interior plate in or out. At the same time the maximum space is available for wires, and no packing is required. The boxes can be set before or after plastering. The patent switch and socket plate, by means of which the wide

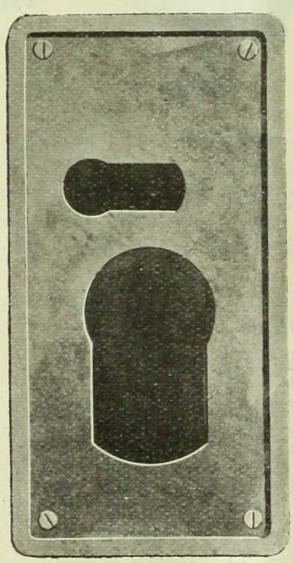


FIG. 2. — SUNCO PATENT SWITCH AND SOCKET PLATE IN CAST IRON BOX. NOTE ADJUSTMENT OBTAINABLE.
(Scale half full size.)

adjustment is obtainable, is shown in Fig. 2. The box will accommodate 5 or 10 amp. switches or wall sockets and is made for 1, 2, 3, 4, or 5 ways. Fuller particulars may be obtained from the Sun Electrical Co., Ltd., of 118-120, Charing Cross Road, W.C.2.

Dinner.—The next Dynamicables Dinner will be held at the Trocadero Restaurant, W., at 7.30 p.m. on Wednesday, 24th inst., Mr. W. B. Esson in the chair.

Correspondence.

CAN ANYONE EXPLAIN?

To the Editor of ELECTRICITY.

DEAR SIR,—Can any of your readers give me an explanation of this strange phenomenon often seen in the cinema? The wheels of cars and carriages, instead of revolving naturally, often appear to go backwards and drag. I first noticed this some years ago in the earliest war pictures and put it down to a defect in the working of a new invention which science had not yet had time to perfect; but the sight of dragging wheels again only a few nights ago in one of America's latest "super films," called, I believe, "The Eternal Flame," set me wondering anew.

Can anyone explain?

I remain, Yours faithfully,

CINE-CAR.

January 15, 1923.

[We cordially invite correspondence on the above interesting point.—Editor, ELECTRICITY.]

WIRELESS IN LEICESTER.

Nearly two hundred of the employees of Gent and Co., Ltd., and their friends "listened-in" to the concert transmitted by the British Broadcasting Co., from Birmingham, on the evening of the 10th inst., in the Faraday Works mess room. Mr. Hardy Parsons, the managing director, presided, and in a brief introduction explained that the evening was arranged in order to give the employees an opportunity of realising the progress of wireless transmission.

At 7 o'clock the concert was switched on, and by the aid of two loud speakers, and using a "Tangent" radio set, the audience enjoyed a continuous concert for three hours, the speech of the entertainer, and the musical items, both vocal and instrumental, being reproduced with remarkable volume and clearness.

The demonstration was particularly interesting to the audience because of the fact that the wireless receiving set used was the standard type of apparatus manufactured by the firm for the use of wireless experiments.

Lectures.—Prof. Miles Walker, M.A., D.Sc., will give four lectures on "The Control of the Speed and Power Factor of Induction Motors," at the Institution of Electrical Engineers (Savoy Place, Victoria Embankment, W.C.2), at 5.15 p.m., on Wednesday, Feb. 21, Monday, Feb. 26, Wednesday, March 14, and Wednesday, March 21. They will form part of the course of advanced lectures in electrical engineering at the University of London.

"**Wireless**" **in 1832.**—According to the current issue of the *Telegraph and Telephone Age*, of New York, a professor at Princeton used a crude method of wireless over ninety years ago in order to send a message from old Nassau Hall, to a building 250 feet away. From President Hibben at Princeton was learned more regarding the wireless referred to. The professor was Joseph Henry, teaching physics at the university. He used an electro-magnetic apparatus, a primitive instrument, by means of which he was able to send signals to a point 250 feet distant. The sending of the signals as described by President Hibben, was in the way of a demonstration before the physics class. The human voice was not carried, but signals were sent to a receiving instrument some distance away without use of wires. As far as is known to-day at Princeton, Professor Henry never did anything further with his instrument.

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THE "SUPERIOR" IRONCLAD SWITCH.

Wm. Sanders and Co., of Falcon Electrical Works, Wednesbury, have just put on the market a new type of quick-make and quick-break ironclad switch, known as the "Superior." The mechanism is of a novel character, the mechanical action being entirely separate from the actual electrical part. The action is controlled by a spindle working from the handle through a mica-insulated square steel sleeve carrying the knife blades. At the end of this spindle is fixed a radially-operating arm with a steel roller at its working end. This roller in turn works on the "V" end of a U-shaped fork carrying the compression springs responsible for the quick make and break action. As a result slow operation of the movement is impossible, and further, when switching on, the formation of the "V" end is such that it is impossible for the switch blades to strike the bottom of the contact blocks.

The absence of springs and other devices around the electrical parts leaves the latter readily accessible, with the result that wiring is made simple.

Reviews of Books, &c.

[Books noticed in this column will be sent from ELECTRICITY *Office to any part of the world, for the published price, plus ten per cent. for postage (minimum 2d.) and orders will be appreciated.]*

METAL TURNING MADE EASY. Cr. 8vo, 152 pp., 177 illustrations. Cassell. 1s. 6d. net.)—This is another of the useful handbooks issued under the auspices of the editor of *Work*. Much of it is from the pen of Mr. Fred Horner, than whom we know of no better authority, and it is certainly a very complete and up-to-date treatise on the practice in small workshops. It is therefore likely to appeal to quite a number of the readers of this paper who are engaged in actual lathe work in the shops or are in charge of isolated plant and machinery, and as such may have to undertake emergency repair jobs in the way of turning, boring, screwcutting, etc., and are provided with a lathe and the necessary etceteras for such work. The book is beautifully illustrated with clear diagrams, and it can be cordially recommended.

THE ELECTRICAL ENGINEER'S YEAR BOOK AND DIARY FOR 1923. 498 pp.—blotting pad and diary; illustrated. (S. Davis. 21s., post free.)—The fifteenth annual issue of this useful diary and indispensable book of reference is now ready, and we have great pleasure in once again bringing its merits to the notice of our readers, many of whom will well remember the first issue of the work—in 1909. At that time there were only 60 pages of technical information, compared with more than eight times that amount in the latest edition, but it was recognised from the first that the publication was an excellent one, and one that would prove of daily assistance to the consultant, the central station engineer, and the contractor. The promise of those early years has been more than fulfilled. The scope of the reference section has been enlarged year by year, and now the title has been modified in order adequately to cover the fact that the diary is no longer the principal feature of the book. The main sections of the year book contain excellently arranged notes upon the generation of electricity, the selection and application of cables, the applications of electricity for power purposes and for lighting purposes, electric motor control, the installation of telephones and bells, electric cooking, heating and cleaning, electric vehicles and electric trucks. In addition, there is a valuable section on trade promotion—a matter of exceptional interest to us all at present—and there are the collection of official rules and regulations, the list of London streets in which electricity mains are laid, and the list of electricity undertakings in the United Kingdom. All of these are well-proven features, any one of which will be worth far more to many readers than the cost of the whole volume. It is difficult to imagine any practical problem to the solution of which this year book will not contribute very materially.

NEW BOOKS PUBLISHED

"Report on the Economic Conditions of Cuba, 1922," 21 pp., 9d. net.
"Report on the Economic Conditions of British West Indies, 1922," 1s. net.
"Report on the Economic Conditions of Argentine Republic, 1922," 1s. 6d. net.
"Electrical Horology," by Langman and Ball. Cr. 8vo, cloth, 164 pp., 68 illustrations, 7s. 6d. net.

Various Items.

Bury.—Mr. S. J. Watson, electrical engineer to the Corporation for 26 years, resigned his position on January 6, having been appointed electrical engineer to Salford Corporation. Mr. J. T. Potts, works manager for 12 years, was appointed his successor at £750 per annum, Mr. Watson being retained in an advisory capacity for six months at £200.

Electro Harmonic Concert.—There was an excellent attendance at the smoking concert at the Caxton Hall, on Wednesday, 10th inst., and the talent provided was much appreciated. As time rolls on one misses many of the familiar faces of men who used to be regular attendants at these gatherings, but the new generation which has joined during the last decade is doing its best to maintain the reputation of the electrical profession for bonhomie and good fellowship, and it is likely that the life of this well-established society will be a long, and we hope a prosperous one.

Company Registrations in 1922.—A statistical report, compiled by Jordan and Sons, Ltd., company registration agents, of Chancery Lane, London, shows that during the past year a very large number of private companies were registered, 7,478 in all, having an authorised capital of over 77 millions. There were 374 public companies with a capital of 42 millions. It is of interest to note the following classes:—Advertising agents, 108, capital £337,070 (private); electricity and gas, 22, capital £6,935,088 (public), 214, capital £714,368 (private); engineers, 9, capital £203,500 (public), 420, capital £4,080,680 (private); kinemas, 32, capital £1,566,000 (public), 172, capital £1,264,975 (private).

The Silvanus Thompson Memorial Lecture.—The first of these lectures, at the Technical College, Leonard Street, E.C. 2, will be delivered by Sir Oliver Lodge, F.R.S., on "The Basis of Wireless Communication," at 7.30 p.m., Thursday, February 1. The chair will be taken by Sir Charles Parsons, K.C.B., and after the lecture a conversazione and reunion of old students will be held. Guests will be received by the Chairman of the College Delegacy (Mr. L. B. Sebastian), the Dean (Dr. W. Eccles, F.R.S.), and the President of the Old Students' Association (Mr. W. M. Mordey, Past-President, I.E.E.). A collection of Dr. Thompson's paintings and apparatus will be shown, and a number of scientific demonstrations will be given in the laboratories by eminent past students and associates of the college. Early application for tickets (gratis) should be made to the Hon. Secretary of the Silvanus Thompson Memorial Lecture, Finsbury Technical College, Leonard Street, E.C. 2.

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Accrington.—The old gas plant at the electricity works is to be sold.

Chichester.—The Special Order authorising the transfer of the electric supply undertaking from the company to the Corporation has been obtained.

Tenders Invited.—The Victorian Ry. Commissioners invite tenders for electric-train lighting equipment (axle generator system). Specification, etc., at the D.O.T. (Room 49), 35, Old Queen Street, London, S.W. 1.

Blackburn.—When the Institution of Electrical Engineers visit Manchester for their annual conference in June next, the delegates will be invited to pay a visit to Blackburn's new super-generating station at Whitebirk.

Alteration.—The paper to be read before the London Students' Section of the I.E.E. on the 26th inst. will be "The Wireless Telephone Service to the Bar Lightship at Liverpool," by Mr. E. A. Payne, and not as stated on the green meetings card.

Tenders Accepted.—Messrs. Geo. Thompson and Co., Ltd., the managing owners of the well-known Aberdeen Line of Steamers, have accepted the tender of the Siemens and English Electric Lamp Co., Ltd., for the supply of electric lamps for the six months ending June 30, 1923.

Armature Winding and Repair.—Mr. Samuel Baxter, mechanical and electrical engineer, who has for many years specialised in armature winding and repair work, has started business at 158, Fulham Palace Road, London, S.W. 6, and will be pleased to quote for the requirements of any readers who may have orders of this description to give out.

Calendars.—A decidedly bold and useful calendar has come to hand from Messrs. J. M. Baxter and Co., the well-known commercial printers of 20, Appold Street, London, E.C.4. Messrs. Baxter have become well known as printers who cater especially for the electrical trade, and we are certain that this new calendar will be much appreciated by their many clients.

More Labour Saving.—Those interested in the increasing use of central heating in this country were given information which would lead to economy in working and also in fuel economy by Mr. B. R. Wingfield, Ph.D., M.I.E.E., at a meeting of the Inst. of Heating and Ventilating Engineers, held on January 12, when dealing with automatic regulation, and in which various types of regulators were described.

Paraguay.—According to the Report of the Economic and Financial Conditions in Paraguay, which has just been published by the Department of Overseas Trade (8d. net), electrical goods to the value of £3,500 were supplied by the United Kingdom in 1914, and only £2,500 in 1921. In 1914 Germany supplied £5,600 and in 1921 £2,600. Evidently they are rapidly gaining ground in these goods, and it is up to the English manufacturers to do their best to improve our position.

Finance.—The Provincial Underwriters' Association, Ltd., of 5, St. James's Place, London, S.W. 1, is offering for sale 35,755 6 per cent. cumulative preference shares of £1 each in the Western Electric Distributing Corporation, Ltd. They are offered at par, and, according to the statement made by the directors, backed by the official balance sheet, they offer a very secure investment, based on the corporation's interest in the electric-lighting undertakings of various towns in the West of England. To us they appear to be an investment which should prove sound and profitable.

A Happy Gathering.—The growing popularity of and the size of the staff of Francis Polden and Co., Ltd., the well-known London electrical contractors, resulted in the indoor and outdoor staffs joining together and organising a dinner and social evening, which was successfully held on January 6, Mr. Francis C. Polden taking the chair, supported by Mrs. Polden, several distinguished guests and the officials of the company. The toast of "Mr. Francis C. Polden and the Company" was ably proposed by Mr. W. J. Revell, and in his reply Mr. Polden said that he had always, in his private and business life, lived to make friends, and added that he would always do his best not only for the company of which he was chairman, but for them all. Mr. A. C. Hill gave a very pleasing and amusing welcome to "The Ladies and Visitors," and Mr. W. T. Smith, a visitor, replied, after which Mr. Polden proposed "The Staff," whom he thanked for their valuable support and remarked on the growth of the fraternal spirit which he felt quite sure existed amongst them, and which was so essential for the success and happiness of them all. Mr. Gill responded on behalf of the "Indoor Staff," and Mr. Plummer for the "Outdoor Staff." There was an excellent musical programme contributed by the "Oursisit Costume Concert Party," and altogether a very enjoyable evening was spent.

FAN AS A SCREW DRIVER.

An interesting adaptation is referred to in *System*, where is cited the conversion of a portable electric fan into a screw-driving machine, which is employed regularly in a factory for inserting screws in certain small metal parts.

In converting the fan into a utility tool, the blades were removed and the end of the revolving shaft was shaped into a driver of the required size. This is covered by a movable collar which rests against a coiled spring. The end of the collar is bevelled to receive the head of the screw.

In operating this machine the workman, who is assembling parts, first starts the screw by hand into its allotted place. Then he presses the screw head against the bevelled end of the movable collar. As the spring gives under his pressure the driver catches in the slot in the screw and the screw is driven quickly into place.

Trade Notes.

In order to enable the **Sterling Telephone and Electric Co., Ltd.**, to cope with the ever-increasing demand in Lancashire, Yorkshire, Cheshire, and Derbyshire, for their various products, they have opened a Branch at No. 14, St. Peter's Square, Manchester (Telephone: City 7035). A comprehensive range of their leading types of telephones and radio apparatus can be seen at the new Branch, where also a suitable stock will be kept for immediate delivery. In addition facilities have been provided for daily demonstrations of "Sterling" Radio apparatus, including the famous "Magnavox" loud speaker, and trade visitors will be cordially welcomed.

Leaflet P.R./751 has just been published by **Messrs. Justus Eck and S. Brook**, of 4, Palmer Street, London, S.W.1 It deals with domestic electric cooking appliances such as irons, toasters, egg-boilers, teapots, table cookers, etc., and should appeal to all factors and dealers in such goods. It is, of course, subject to liberal trade discounts, and copies may be obtained on application. Also a copy of their January stock list, No. 29, giving illustrations and prices of their direct and alternating current motors, which list they will be pleased to send to trade readers, installation contractors, etc., on application.

The January "Wholesale Electrical Accessory List," issued by **The London Factors and Agents, Ltd.** (38-9, Parliament Street, S.W. 1), gives net prices arranged in such a way as is calculated to save contractors time in estimating. The prices are competitive.

In List No. F/19 **Meldrums, Ltd.** (Timperley, near Manchester), illustrate and describe their oil burners, of which seven were recently supplied to a gas department for burning residual oil from low-temperature carbonisation.

Elaborate new showrooms have been opened at Daimler House, 33-34, Paradise Street, Birmingham, by the **Metropolitan-Vickers Electrical Co., Ltd.** A leaflet dealing with heating and cooking appliances, fittings and accessories was produced in connection with the opening, to which special invitations were issued to the trade. A great many people responded.

"The Children's Hour" is the title given to an attractive and well-reproduced showcard depicting the advantages of the Cosmos radiant fire, which has just been issued by the **Metropolitan-Vickers Electrical Co., Ltd.**, of Trafford Park, Manchester. It is actually an advertisement of the company's 2-kw. radiant fire, and should prove helpful in bringing orders for this very efficient heater element. Factors, contractors, etc., who have not yet received copies of the showcard should make a point of writing for it and making good use thereof in their showrooms and windows.

Fibre Tube.—An advertiser wishes to dispose of about 5 lb. For details see a small advertisement.

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THE MISTAKE OF INSTALLING SMALL BATTERIES.

By G. Taylor.

The country house plant or the village electricity works to-day have to cater for small power as well as lighting. The great convenience and economy of the electric iron, the grilling and boiling stove, and the full-sized cooking oven, together with radiators, are recognised perhaps more fully in the outlying country installation where help is not always certain and where the community or house is of necessity self-supporting.

On this account the installation of an undersized battery is a greater mistake than in former days.

Whilst interviewing three possible clients in the country situated near to the writer's office, the point urged against the installation of private plants was that at Mr. X.Y.'s they had experienced a lot of bother and nuisance with the light, and that it would be far better to wait for the company's supply coming into the district. This latter event was, owing to the thin load, extremely improbable.

Seeing that this particular installation was hanging up business by its poor example, the writer ferreted out the man who looked after this inefficient plant at a local hostel some four miles off, and asked permission to look round the place.

The approach had been obtained through asking the host of the inn why he did not go in for a private electric light plant instead of using oil lamps; the instance of Mr. X.Y.'s experience was again mentioned and his man pointed out in another room.

On interrogating this man it was found that he was no engineer, and that his complaint was that the plant would not give a good light except for two hours after the engine had been shut down, and that he was often called out at 9 p.m. to run up again for two hours.

Examination of this plant showed the reason. The battery had been installed of just sufficient capacity to give about four hours' work with full load on the house when the installation was first put down and to take one or two lights all night if necessary. This had been done in order to keep down the capital cost of the installation, to a man who could well have afforded a thoroughly well laid out plant.

Now mark the consequences: it was not Messrs. A.B., of Carminster, who were blamed; they were stated to be the best firm in the district for miles round; consequently it *must* be the fault of private electrical installations, which were a nuisance and a source of worry and bother.

Naturally other folks in the district did not care to experiment where their wealthier neighbour had apparently failed to get satisfaction.

The firm who carried out the installation were large millwrights, used to dealing with heavy motor problems and shafting jobs in large works, and, moreover, were on an A.C. system and unaccustomed to batteries and battery working. The battery seemed to be the most costly portion of the plant and it was consequently skimped with the idea that it would get through an occasional evening's entertainment without distress.

During the first winter the battery, being new, stood up well to its overload on several occasions and gave practically no trouble.

Now it is not policy to discharge a battery down to 1.8 volts per cell repeatedly; and no provision of end cells is going to make up to the main battery for the strain so imposed; the use of end cells to carry the voltage through a falling period such as that between 1.9 and 1.8 volts per cell merely boosts up the voltage for a short time, drags out the strain on the main battery, but does not *relieve* that battery.

It may be asked how, if the size of the battery is increased, can the cost of the installation as a whole be kept low enough to prove attractive. The method is to treat the battery not as a handy auxiliary but as the most important item.

Lay out the installation so that the cells can carry the full load offered by the house, from 4 p.m. on a winter's day to 12 midnight, without dropping lower than 1.85 volts per cell, and arrange that for entertainments the engine is run from, say, 4 p.m. to 7 p.m. This will then permit the cells to be well above their load and will not interfere with the general work of the estate.

This lay-out will not increase the cost of the whole plant if the size of the engine and generator be cut down so that the battery can be charged fully by running the engine for eight hours on end fully loaded. It is a mistake to put down an engine and dynamo large enough to run more than the complete installation and to charge the battery as well, and then to install a battery capable of acting only as an auxiliary, giving only a few hours constant full load to the engine even in the depth of winter, and necessitating the engine running late every night throughout the dark months; this is not economy in any sense.

A man can start up an enclosed type crude oil engine at 8 a.m., switch up, set the machine charging the cells, and then leave the plant for two to three hours on end; these plants are all protected by reverse current cut-outs. Let him visit the plant at 10 a.m. and again just previous to his dinner at twelve, and on each occasion make the adjustment to the charging current called for on the battery-maker's schedule. A third visit to the plant at 1 p.m., followed by another at 3 p.m., and a final visit at 4 p.m. to see that the cells are charged up and to shut down the engine will not upset the handy man of the estate who usually runs the engine on the smaller installations; whilst on

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the larger installations the estate engineer will have his workshop near to the engine room, and will hardly need to interrupt his daily routine and repair work in looking to the plant.

It may be urged that by carrying out this idea of a small generating set and a large battery, a danger is being run of having the lights off; this is a peculiar idea, and though quite a fallacy, is widely held. The reverse is actually the case. The battery is far less likely to break down than the engine and dynamo; whilst even if the engine and dynamo were large enough to run an installation double the capacity, there would still be a hang-up if the engine or machine were down; and as the battery in such cases would be of the usual small capacity, it follows that the complete shut down of the whole plant is more likely under that system than under the method now recommended of large batteries and smaller generating sets.

When the installation is first laid out, find out exactly what ideas the owner has as regards electricity; if he wishes only for light, and an odd water pump or two about the estate, then do not urge the convenience of the many other domestic uses too early. Such a policy is apt to make him think the installation is going to run him to a very heavy expense; and if urged untactfully, will make him resent the idea. Let him, and in particular his good lady, see the benefits of the light to start with, and they will be bound to see at the houses of their friends such lines as toasters, irons, fans, and small motors for running the kitchen, farms, and wash-house, and will ask for them; they will also be open at such a time to consider the installation of another small engine and dynamo, if necessary. Thus the installation will be of reasonably low first cost, and will be increased in capacity as and when necessary; the battery being already large, will not be upset by this additional load, which will mostly come in the day time. The addition of another generating set will, however, carry the extra load, give a good stand-by to the whole plant, and increase the efficiency of the installation as a whole.

It is no use arguing that once a country house proprietor has installed one plant he will not think of additions. He will do if approached properly; the use of electrical appliances is a growing one about house and farm. No electrical man worth his salt can stop satisfied with a house electrically driven, whilst the farm, the dairy and wash-house are run in the old way. All these demands mean extra power, and it can be proved to the proprietor that they are well worth it; under the usual method, the contractor who has put down too small a battery at first soon finds that it is too small for the house evening load, and that the generating set is busy on other matters, with the load having increased.

With the increase in the farm and domestic load, my lady has put in dressing-room radiators, many little bedroom and toilet conveniences which electricity alone can supply, and so, on to the overworked battery, comes this extra load of an evening.

The large battery can meet the extra load, and is helped by the extra engine and dynamo brought into the installation at the correct time; that is, when it is needed.

When a village electrical scheme is being considered, then the small battery is not only a mistake, it is almost a crime. Not only does the large battery allow a small initial generating set, but it keeps it loaded up to test load, and gives economical running; whilst by its capacity it cuts down the attendance item to the lowest possible point, and puts up the stand-by capacity very considerably; in addition, it allows the concern to reserve its capital until actually required by increasing load.

The most important point is that it allows the company to take on motor loads in the district without the necessity for another shift having to be run in the day time. The writer does not forget being called in to advise a certain country institution with regard to its power load some little time back, and finding that the whole trouble was due to the smallness of the battery installed at the local generating station.

The manager of the institution informed the writer that the electric light man worried him to run the place by power from the mains, and then, six weeks after getting the place equipped, came round and ordered him to stop running two particular motors except at certain times, as they were running down his battery! The writer offered to interview the generating station engineer and his Board, and to persuade them to install further battery power, and meanwhile to run another shift and swallow the loss. This the manager of the institution would not hear of. "They do not know their business," he stated, "or I should not have been in this mess. Consequently, I am having no more of them; and were they worth while taking to court I would do so." He insisted on a plant being installed on his own premises, and to-day there is the spectacle of two small plants, each at one end of the village, each needing some little attention, each rather less efficient than if they had been centralised, and each detesting and hindering, in place of helping one another, simply through too small a battery being installed in the village power-house at first.

THE BRITISH INDUSTRIES FAIR.

The interest centring in the British Industries Fair (Birmingham), which is to be held between February 19 and March 2, is quickening appreciably as the time draws near.

This will be the fourth successive year in which the Fair has been held, and will to all appearances be the most successful. The number of exhibitors is the largest on record, and several of the sections, which comprise hardware, metals, engineering, building, brewing, and numerous others, have been enlarged.

It also appears that the number of visitors will be exceptionally large. Admission is only to *bona fide* buyers, by official invitation, or on presentation of a trade card, and already over 800 requests for invitations have been received by the Board of Trade from all parts of the world.

The British Industries Fair (Birmingham) is undoubtedly a great and very important effort on behalf of British trade, and the whole country wishes it success.

H.R.H. the Duke of York has, we understand, arranged to visit the Fair on February 22.

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A HAPPY HOUSEWARMING.

On the 16th inst., Mr. Howard Marryat, the president of the Electrical Contractors' Association, Mr. W. R. Rawlings, Mr. Shaw and other past-presidents, together with Mr. Leonard G. Tate, the genial and wideawake secretary, invited the representatives of the technical Press and various other friends (including Mr. Rowell, of the I.E.E., and E. D. A. Beauchamp) to an informal but happy cup of tea in the new home of the Association, at 15, Savoy Street, London, W.C.2. It was quite a homely little function. We drank the tea and ate the cakes, inspected and admired the new offices, looked with interest at various specimens of ancient electrical accessories exhibited by Mr. Parsons, of Gloucester, and passed the time of day generally. Mr. Marryat then told us in a few appropriate words how the Association was progressing, and thanked the electrical Press for the support which had been so ungrudgingly given. He mentioned the work and tact involved in handling the negotiations with the unions representing labour interests, as well as those associated with the manufacture of different classes of electrical supplies, and asked for support in their efforts to gain for the electrical trade the retailing and fixing of the wireless receiving sets which are now the craze. Mr. W. R. Rawlings also spoke, and remarked incidentally that the endeavour of the E.C.A. to obtain proper co-ordination in the arrangements with manufacturers was the real cause of the Beama being started. Mr. A. H. Allen, of the *Electrical Review*, responded for the Press, and we went our several ways indulging in the sincere hope that the E.C.A. will flourish exceedingly in its new home.

S. R.

THE PROTECTION OF INVENTIONS BY LETTERS PATENT.

At a meeting of the informal section of the I.E.E. on Monday, 8th inst., Mr. R. Grierson was in the chair, when Mr. E. W. Moss opened a discussion on "The Protection of Inventions by Letters Patent."

Mr. Moss first sketched the origin and history of patents. These apparently arose in the 14th century out of protective licences to foreigners specially introduced to ply their craft or skill in this country. These licences were subsequently elaborated into the "Statute of Monopolies" of 1624, and eventually became the progenitors of all patent law.

The opener explained with considerable detail the nature and operation of patents in the United Kingdom, and also sketched the laws of foreign countries. He urged the need of a patent law that should be general to the British Empire, and also made the suggestion that an impoverished patentee should have access to the law *in forma pauperis*. He gave the following general advice to inventors:—

See the application is filed as soon as possible.

If possible, make no publication before acceptance

See renewal fees are paid in good time.

Generally beware of patent brokers, so termed.

If you find your patent is being infringed, be careful not to threaten the infringer.

If you have an improvement in your patent, be sure it is covered by the specification, or else apply for a new one.

Keep careful and separate accounts of moneys expended or received on patents. Because, if you have occasion to apply for an extension, you will require these particulars, which are often most expensive to ascertain after a lapse of time.

Various gentlemen joined in the discussion, and Mr. Moss replied in detail to the points raised.

NI-FE ACCUMULATORS.

Although the NI-FE accumulator has been on the market for over ten years, it is comparatively only recently that Messrs. Batteries, Ltd., of Redditch (who obtained the patent rights for the United Kingdom), have been able to complete the equipment of their factory, which is the only one in this country manufacturing nickel-iron accumulators.

The factory is situated at Crabb's Cross (about 3 miles outside Redditch), and is fitted with most modern equipment, automatic machinery being employed wherever possible, thus eliminating the possibility of errors due to the human element. Perhaps the most

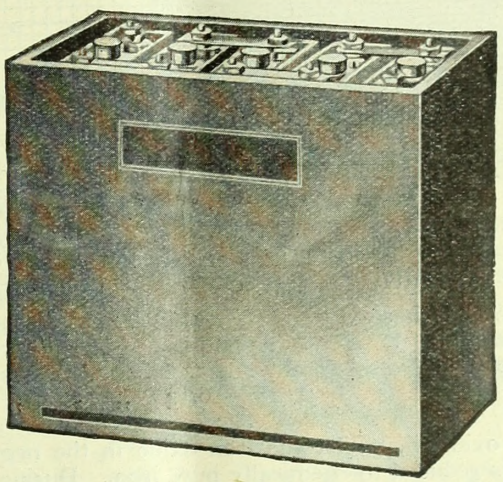


FIG. 1.

interesting machine is one which makes the strip electrodes. This machine automatically makes briquettes of the active material, feeds them between two nickelled steel strips and clamps the latter to form the strip electrode. Other interesting departments include a well-equipped power house capable of supplying power and lighting for factory and office needs, a welding shop, a filling department and a testing department.

Fig. 1 shows a typical NI-FE accumulator, and one should here mention in a general way its constructional details. The positive plates consist of a number of nickelled steel perforated strips, into which are packed briquettes of nickel hydroxide and other ingredients. These strips are held together in a steel frame which forms the complete plate. The negative plates are constructed on similar lines to the positive ones, the only difference being that the active material is ferrous-

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oxide specially prepared and mixed with other ingredients.

The insulation consists of para rubber strips between tne plates. Plates of similar polarity are connected by a steel plate brazed across their tops, and to which in turn is brazed a pole terminal.

There are no nuts or screws which can become loose and cause a short circuit.

The container is made of steel, all joints being brazed, thus preventing any possibility of leakage of the electrolyte. There is a special gas valve in the cover. The electrolyte consists chiefly of potassium hydrate in distilled water.

The cells are available in two types: "A" for slow and "K" for rapid discharge. The former is also known as the normal internal resistance type and the latter as the low internal resistance type.

An idea of the electrolytic reactions which occur during charge and discharge may be gained from a consideration of the fact that a discharged cell contains, in the positive electrode, nickel hydrate in a low degree of oxidation, whilst the negative electrode contains chiefly iron oxide. When charging takes place the nickel hydrate in the positive plates becomes more

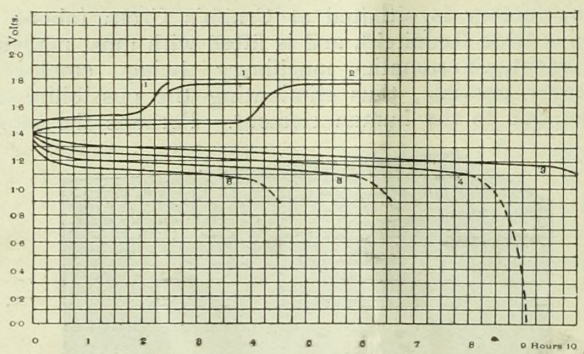


FIG. 2.—CURVES SHOWING THE RELATION BETWEEN VOLTAGE AND TIME OF A NI-FE CELL FOR SLOW CHARGE AND DISCHARGE (NORMAL RESISTANCE TYPE).

1. Forced charge.
2. Normal ,,
3. 10 hours' discharge.
4. 8 hours' discharge (normal).
5. 6 hours' discharge.
6. 4 ,, ,,

highly oxidised, whilst the iron oxide in the negative plates is reduced to chemically pure iron. During this process the electrolyte does not take any apparent part in the reactions, and it has the same density before and after charging.

On discharging, the active material in the negative electrode becomes re-oxidised, whilst that in the positive electrode is reduced. The charging and discharging processes are apparently nothing more than the electrolytic carrying of oxygen from one plate to the other. The electrolyte does not enter into any permanent chemical union with the electrodes, but functions practically only as a liquid conductor. For this reason the quantity of electrolyte can be reduced to a minimum, and the plates can be placed as close together as is practicable.

The curve for a normal charge (six hours for normal resistance type and five hours for low resistance type) shows that the voltage at the beginning slowly rises during about 70 per cent. of the charge time from 1.4 to 1.5 volts, and then rapidly to 1.75 to 1.78, and remains so to the end of the charging. By using the method of forced charging the time can be reduced to four hours for normal resistance type and three-and-a-half hours for low resistance type. In this method a double current is used during the first 60 per cent. of the charge, which is then completed with normal current. During charging, some of the water in the electrolyte is decomposed and flows out as oxyhydrogen gas. This gas is not corrosive, and overcharging is not injurious to the cells.

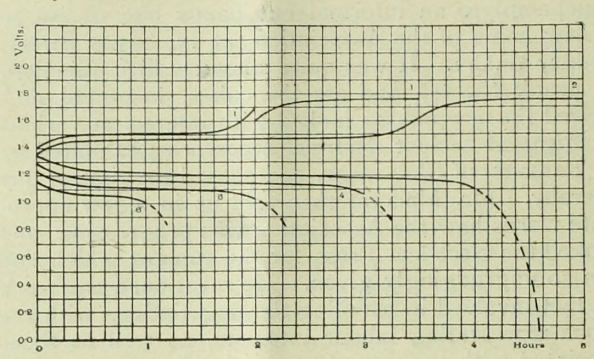


FIG. 3.—CURVES SHOWING THE RELATION BETWEEN VOLTAGE AND TIME OF A NI-FE CELL FOR RAPID CHARGE AND DISCHARGE (LOW RESISTANCE TYPE).

1. Forced charge.
2. Normal ,,
3. 4 hours' discharge (normal).
4. 3 hours' discharge.
5. 2 ,, ,,
6. 1 ,, ,,

The curve for a normal discharge in eight hours (for normal resistance type) and four hours (for low resistance type) shows an average working voltage of 1.2 volts. The voltage drops slightly during the first fifteen minutes of discharge, but after this it remains practically constant until the cell is completely discharged.

Other curves show the voltage for discharging in shorter and longer times than the normal.

As no gases are generated during discharge the cells can be made unspillable. We understand that a NI-FE battery will give about 90 per cent. of the guaranteed output, even when discharged with a current four times the normal; the ampere-hour efficiency under normal conditions being from 75 per cent. to 80 per cent., and the corresponding watt-hour efficiency is from 60 per cent. to 65 per cent.

Other particulars and examples of the very varied purposes to which the cells may be put in practice are given in a booklet which may be obtained by readers interested in power storage cells on application to Messrs. Batteries, Ltd.

Tenders Invited.—The Post and Telegraph Department, Wellington, N.Z., invite tenders for 3,000 switchboard plugs. Tender and a sample switchboard plug can be seen by British firms at the D.O.T. (Room 49), 35, Old Queen Street, Westminster, London, S.W.1.

Wireless Insurance.—In a recent issue we referred to the scope which the new "broadcasting" craze offered to any insurance company which would lay itself out to cover the risks specially applicable to owners of wireless sets, and we also stated that the Liverpool, Marine and General Insurance Co., Ltd., of 62, London Wall, London, E.C.2, was actually issuing such policies. Wireless readers and enthusiasts will be interested to know that the company have issued a neat and well-bound pocket diary for 1923, and policy holders may possibly get them if application be made promptly. Moral: If your wireless set and aerials be not insured, get them insured forthwith.

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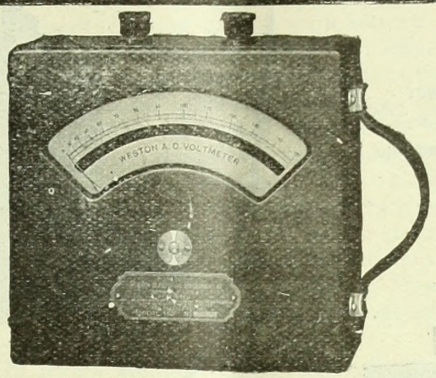
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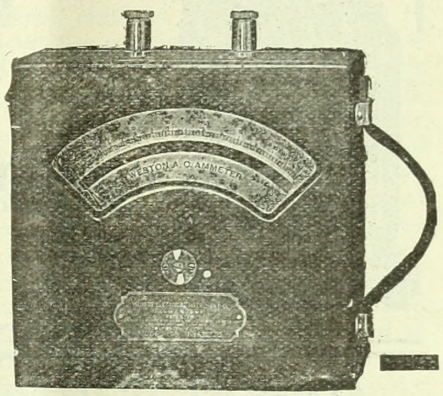
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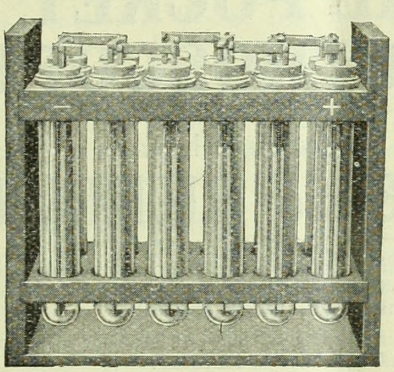
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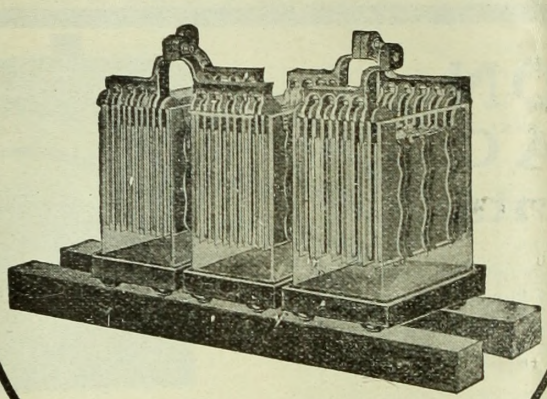
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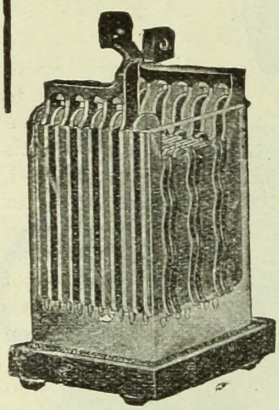
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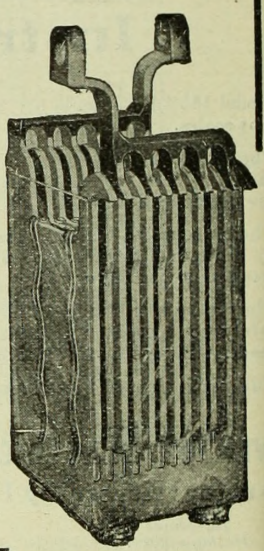
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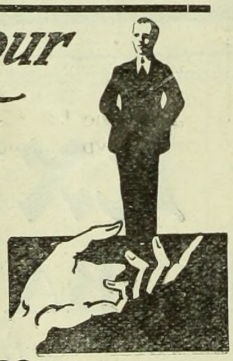
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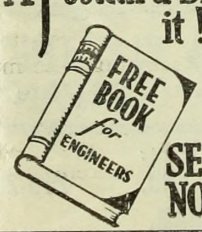
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TO OUR READERS.

ELECTRICITY is published every Friday, and, if ordered, is on sale at the principal Railway Station Bookstalls and Newsagents on that day. It has a very large sale throughout the United Kingdom, as well as in the British Colonies and Abroad.

Questions to which an answer is required must be accompanied by a 1½d. stamp for reply. When considered of sufficient interest, the answer will probably appear in the paper.

New advertisements for the displayed columns and alterations to existing ones must reach the publishing office not later than first post Tuesday morning, in order to be in time for the issue of the following Friday. This is important. Rate quoted on application. Subscription: 13s. a year, 6s. 6d. half year, 3s. 3s. a quarter in advance, postage prepaid in the United Kingdom and abroad.

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Current Topics.

The Gas Peril.

With the therm agitation still rampant, our friends of the gas industry are faced with yet another crisis which is imperilling the popularity of this illuminating and heating agent. We deprecate the slinging of mud at a competitor, and have no desire to add to the difficulties of gas managers and engineers at this juncture. The leading gas organs, however, are not so considerate in their treatment of electrical topics that we can afford to let the present outcry pass without interested comment. According to coroner's inquiries at the various inquests which have been held lately into fatalities caused by gas poisoning, it is abundantly evident that the permissible percentage of carbon monoxide in gas supplied to the public is at present far too high having regard to the very deadly nature of this gas, and the question arises whether its admixture should be permitted at all, or an embargo placed upon it in view of the danger to public health.

As high a percentage as 15 per cent. of carbon monoxide is reported present in certain samples which have been analysed, and medical opinion is that one-half per cent. or over is sufficient to prove fatal in certain cases. If this be true, gas authorities cannot get away from the fact that we have actually laid on to our houses and available at any burner or outlet one of the deadliest known gases. Nor is it necessary for the mixture to be actually laid on, or a gas tap left leaking, since a recent incident reported involved fatalities through the breakage of a street main in the vicinity of the house in which the victims were asleep. The danger is accentuated by the fact that gas fittings, especially those which have been in use for any length of time, are so prone to develop leaks; taps lose their stop pins and are apt to be turned half on again; old compo pipes become brittle; red lead packing perishes; and, in short, one is never certain that leakage is not taking place at some point or another without one being aware of the fact.

We have no quarrel with gas interests, there is ample room for both. We only claim to supply a better, safer, and more convenient medium for illumination, heating, cooking and power; most of us of the electrical fraternity use gas in some form or other, either at our homes or in our business premises and workshops, however, and, for our own safety we add our plea to that of the public at large, now being voiced in the lay Press, for a reform in the official regulations which at present permit the gas suppliers to poison us at their own sweet will.

The Budget and Education.

With rumour busy regarding the economies anticipated by the Chancellor of the Exchequer in the forthcoming Budget, I sincerely hope Mr. Baldwin is not losing sight of the harvest which would accrue from a generous application of the scythe to the present crop of public expenditure on Education, both local and Governmental. In effect, the present system of making Government grants proportionate to local expenditure actually encourages extravagance on the part of local education authorities, since, the more they spend out of the rates the bigger the allocation out of Imperial taxation. The public pays both charges, which at present amount to considerably more than he can afford, even if he be a family man well blessed with offspring. In this connection the remarks of Sir Alfred Hopkinson, formerly Vice-Chancellor of Manchester University, are of topical interest.

He refers to the Scholarship fallacy of our present system, whereby every child is theoretically able to qualify for the Universities on the basis of free elementary education. Very few are really fitted for this training, which is, nevertheless, open to them, and, of course, costs money, which might be better expended in fitting them for more profitable walks of life or alternatively saved, to the advantage of the tax and ratepayer. Incidentally, the voluntary offer of London elementary school teachers to forego 5 per cent. of their salaries does not appear to have been the thoroughly disinterested action it was regarded at the time. In London, salaries come up for revision this year, and if, as is anticipated, they are reduced to the next lowest scale, it would be equivalent to a reduction of 10 per cent. Thus the teachers have chosen the lesser evil by intelligent anticipation.

The Law's Definitions.

That the Law is an Ass was declaimed by a certain well-known character quite a long while ago, and certain of its definitions would certainly appear to bear out this allegation. Thus, Judge Terrell at Torquay County Court recently held that a tenant could not claim protection under the Rent Act since the house he occupied had been let "furnished," said furniture consisting of a bath, geyser, and electric light fittings, and he would have been subject to a lower rental had the house been without these convenient accessories. It will be interesting to note whether this decision prompts leading furniture emporiums to include the sale of electric lighting and heating accessories as a legitimate feature of their business. Incidentally, people in search of "furnished apartments" would do well to satisfy themselves before closing with any offer that they will not be called upon to sit in the bath, cook their meals on the geyser, and hang their clothes on the electroliers as constituting the only "furniture" covered by the description.

Broadcasting Humours.

The new pastime is bringing quite a lot of amusing incidents in its train. For example, there is the enthusiast who, warned by the dealer that he must not allow his aerial to oscillate, protested that it was impossible to prevent it, his house being in an exposed position on top of a hill, and subject to high winds, which kept his aerial in a continuous state of

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visible oscillation. Then there is the demure flapper who wants to know whether aerial oscillation has anything to do with being kissed in mid-air by a good-looking pilot on the Paris-London air service. Last, but not least, we have the amateur listener-in of an inquiring turn of mind, who wants to know why it is necessary to keep all those little lamps burning in the daytime, when you can see to adjust the set quite well without them.

Broadcasting is also creating an entirely new nomenclature, such terms as "blind spot," meaning a location where it is practically impossible to obtain any reception; "fading," or the dying away of voice and music at intervals; "howling" of valves, etc. Incidentally, "fading" would appear to have been one of the principal difficulties experienced by certain listeners-in to Covent Garden opera last week, one amateur giving it as his opinion that the effect was in part due to the movement of the singers from one side of the stage to the other, and their consequent greater distance from the transmitter. However, I should scarcely attribute the phenomenon to this cause, since the promoters will, no doubt, have adopted standard Electrophone practice in placing their transmitters at the Opera House. On Electrophone circuits it is usual to connect "groups" of transmitters to the respective outgoing circuits, each group being made up of equally spaced transmitters located in both wings and the float respectively. Thus, the sound lost by a transmitter in any group on, say, the O.P. side would be picked up by one in the opposite wing; or, if the artiste was at centre stage, by one in the float. It would be interesting to know whether this "staggered" grouping was adopted for the telephone transmitter circuits to Marconi House as arranged for the first stage in transmission.

An Optical Illusion.

Apropos the phenomenon referred to by a correspondent in last week's issue, whereby the wheels of a moving motor car, shown as a cinema film, appear to drag and rotate backwards, this is purely an optical illusion, or stroboscopic effect arising out of the lag or lead of the camera used in making the film in the first place, or may be in part attributed to the lack of synchronism between the speed of the wheel, the rate at which the photographs were taken on the film, and the speed at which they are successively exposed on the screen. The curious effect of a wheel apparently turning backwards is due to the momentary picture of a new group of spokes, actually in advance of those next the ground, apparently reappearing behind the point of contact of the tyre with the roadway. Given perfect synchronism it would be possible to show a car actually travelling at high speed, but with its wheels apparently stationary. The substitution of disc wheels, of course, destroys the illusion ELEKTRON.

Sincere Congratulations.—At the meeting of the I.E.E. to be held on Thursday, February 1, the President will present to Mr. J. W. Meares, C.I.E., M.I.E.E., late Local Hon. Sec. of the Institution in India, and Electrical Adviser to the Indian Government, a salver and cigarette box subscribed for by his friends in India on the occasion of his retirement from the Indian Government Service, and as a token of his valuable services to the profession in India.

"WIRED WIRELESS"—LINE RADIO.*

By Major J. A. Mauborgne, United States Signal Corps.

Four or five years ago the average telephone man gave scarcely any consideration to the subject of linking together radio telegraphy and telephony with wire line telephone systems. Multiplexing methods based upon the older arts of telegraphy, by which a multiplicity of telegraph messages were superimposed upon telephone circuits, were about the only combination in practical use so far as telegraphy was concerned, and for straight telephony the use of the phantom circuit afforded practically the only means for securing an additional telephone circuit over two physical telephone circuits.

Of course, there were a number of men in the telephone field who were interested in radio as a purely separate means of communication, but these men grew up in the radio world, ordinarily without linking together the wire and the radio circuits, of which they had a working knowledge.

To-day we are forced to the conclusion that henceforth the telephone engineer must seriously study radio telegraphy and telephony, for "wired wireless" has come to stay, and the telephone engineer must be awakened to the possibilities of this later art, if telephone companies are to take advantage of the opportunities for multiplexing their lines at a considerable saving of copper; of furnishing additional channels for broadcasting over their lines, and of making careful study of the situation created by the immense demand for radio antennæ, in apartment houses, hotels, and other congested places, which would permit their subscribers to make use of their lines as antennæ for the reception of broadcasting, sent not only over their lines proper, but of material broadcast through the ether by radio stations in the normal way.

At a gathering of this sort one cannot impose upon the good nature of his hearers by presenting the whole history of any art or going into all its ramifications. I deem it impracticable to present for your consideration an outline of the fundamental principles of radio telegraphy and telephony such as is really required for the student of "wired wireless," prior to a discussion of this later art. Excellent articles dwelling on radio fundamentals have recently appeared in some of the monthly telephone publications. I feel, however, that there is no telephone man here present who has not, at least, some knowledge of how radio transmission and reception are carried out.

I shall attempt to confine my remarks, therefore, in the brief time I have at my disposal, to a discussion of "wired wireless" in its simplest form, and to explain and demonstrate, if time and circumstances permit, how multiplex telephony may be accomplished by the superimposition of modulated radio currents on telephone and lighting lines, and, also, to dwell for a short time on the possibilities of applying Major-General Squier's inventions connected with broadcasting over telephone lines, as well as on the use of such lines as antennæ, and on the part to be played by telephone companies in such application.

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* *Telephony*, Chicago.

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"Wired wireless" is, perhaps, the best-known term and the oldest term applied to the system of multiplex telephony and telegraphy employing high-frequency currents on wires. It has been variously called "carrier wave" telephony, "wire radio," "line radio," and many other names purporting to give a more or less correct description of what actually takes place when this system is used.

For many years after its discovery by Major-General George O. Squier, the present chief signal officer of the army in 1909, it bore the name "wired wireless," although its inventor at present prefers the title "line radio," as distinguishing it from "space radio," which latter term is sufficiently descriptive to require no further explanation.

"Wired wireless" was first achieved by Major-General George O. Squier (then Major Squier) during the years 1909 and 1910. In November, 1910, General Squier filed fundamental patent applications on the "wired wireless" art, on which patents were allowed in the year 1911. In this same year he published a paper on "Multiplex Telephony and Telegraphy," which marked an epoch in the scientific progress of the telephone and telegraph art.

Many inventors prior to General Squier's work had been engaged upon the problem of multiplex telephony and telegraphy, but all of the ideas underlying the schemes which hitherto had been proposed were based, almost without exception, upon the principles and practices of the old telephone art. The great advance made by General Squier and that which made the use of high-frequency (radio) carrier currents successful was the combined utilisation of tuned radio circuits and a detector or rectifier at the receiving terminal.

For this transmitter he used a high-frequency alternator, which he coupled by means of a radio circuit either directly or inductively to a telephone line, and at the receiving end by means of properly tuned circuits, and with a detector—first of the crystal type, and then in 1910 of the audion or valve type—he first demonstrated the practicability of transmitting speech over a wire without that speech being heard by the ordinary telephone instruments attached to the same wire. By this achievement the common principles of the radio art were immediately made available to the older wire systems, and a new method of transmission of intelligence was created.

Upon the announcement of the invention a number of engineers attacked his proposal, and maintained, after mathematical analysis, that the attenuation of the high-frequency currents on the wires would make the scheme impracticable for multiplex telephony. It is to be noted, however, that the comments of the engineers mentioned were made in the days when modern radio amplifiers did not exist. It is to be noted, also, that these same engineers proceeded at once to experiment with the proposed system.

The modern amplifier makes possible the reception of extremely small amounts of energy and the magnification of the sounds produced thereby so as to give strong signals. The high-frequency alternator used by General Squier was, at the time of his invention, in the experimental stage, and did not appear to afford a practical solution as a source of energy for commercial multiplex telephony. It was not until the arrival of the three-electrode vacuum tube as a generator of high-frequency current that real progress was made toward the practical realisation of the scheme. The practical development of the new art of utilising low-frequency carrier currents and the solution of the actual problems of making a practical multiplex telephone circuit have now been carried to an advanced and commercial stage, and long distance telephone and telegraph lines employing the system are in daily operation between a number of large cities.

In this country (U.S.A.) honour is due to the research staffs of the Western Electric Co. and the American Telephone and Telegraph Co., and particularly to E. H. Colpitts and C. B. Blackwell, for the development of a practicable system. That this country is not alone in the development of this new art is evid-

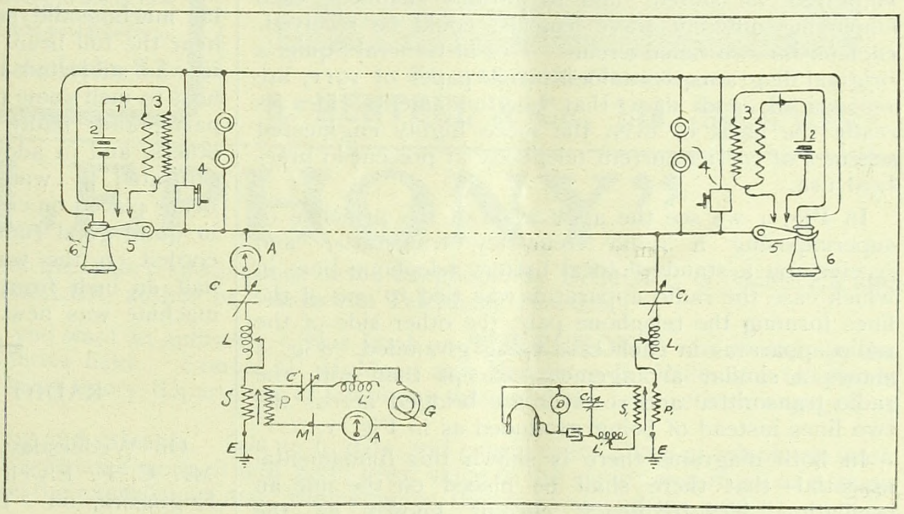


Fig. 1. Application of Principle of Superimposing a Radio Frequency Transmitter and Receiver on Standard Local Battery Telephone Line.

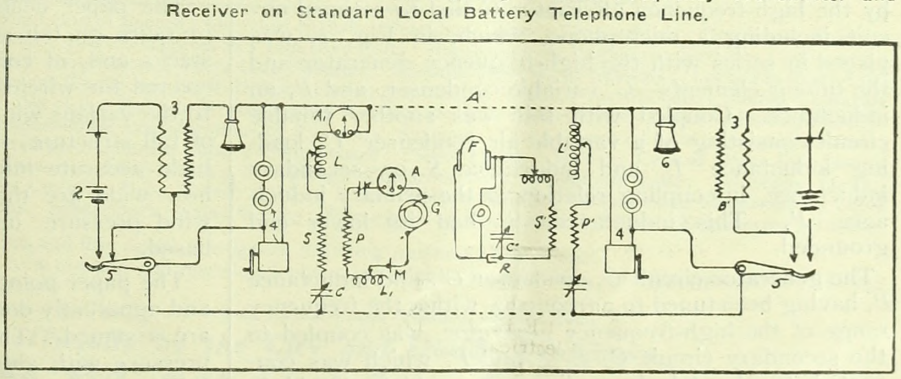


Fig. 2. Superimposing a Radio Frequency Transmitter and Receiver on Standard Local Battery Line with Receiver and Transmitter Bridged Across Line.

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enced by the publications of Wagner, Faszbender and Habann, in Germany, and of Marumbo in Japan. The first two papers mentioned contain interesting accounts of the development of wired radio apparatus in Germany during the war; the latter paper, though quite brief, is also of great interest, as it contains descriptions of methods and apparatus used where a high voltage power line was employed for transmission means.

A very excellent contribution to the literature on the subject of "wired wireless" is to be found in the paper by E. H. Colpitts and C. B. Blackwell, which is recommended to those who are seriously inclined toward the study of "wired wireless." This paper very well outlines the method of carrier current telephony used by the Bell companies to-day.

In the Signal Corps of the army very little was done towards the development of "line radio" or "wired wireless" for some time before and during the recent war; but, since that time, a number of papers have appeared in the scientific press recording the achievements of various Signal Corps engineers, particularly R. D. Duncan, jr. References are made in the footnotes to this paper to all the articles mentioned herein.

The original idea conceived by General Squier in 1909 was simple enough: The ether waves set up by the transmitter were simply to be guided by the wires. Tuned circuits for reception and transmission were employed as stated, and so various channels, each employing different wave lengths, could be received, each on its own tuned circuit. Two of General Squier's original diagrams, contained in his paper of 1911, are reproduced, and show that his fundamental idea is really the basis of even the more highly engineered schemes of carrier current telephony at present in practical use.

In Fig. 1 we see the application of the principle of superimposing a radio frequency transmitter and receiver on a standard local battery telephone line, in which case the radio apparatus was tied to one of the lines forming the telephone pair, the other side of the radio apparatus in each case being grounded. Fig. 2 shows a similar arrangement, except that both the radio transmitter and receiver are bridged across the two lines instead of being grounded as in Fig. 1.

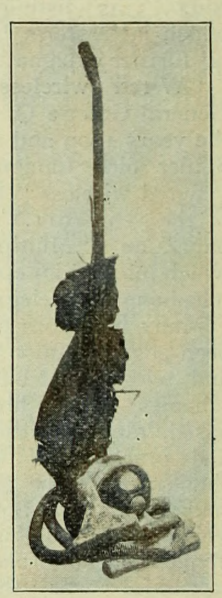
In both diagrams there is shown this fundamental essential—that there shall be placed on the line an oscillating high-frequency current known as the "carrier," supplied, in the particular case mentioned, by the high-frequency alternator G tied to a tuned circuit including a microphone, which, in Fig. 1, was placed in series with the high-frequency generator and the tuning elements—C^1 variable condenser, and P, an inductance. Coupled with this was another tunable circuit consisting of a variable air condenser C, loading inductance L, and inductance S or secondary inductance, in coupling relation to the primary inductance P. This inductance, S, had its lower end grounded.

The generator circuit G, condenser C^1, and inductance P, having been tuned to a frequency within the frequency range of the high-frequency generator, was coupled to the secondary circuit C, L, S and P, which was connected to the telephone line over which the high-frequency current was to be sent. The ammeter, A indicated when the secondary and primary circuits were in tune, resonance between these two circuits being indicated by the maximum reading of the needle.

The primary or generator circuit in this case was modulated by the microphone M, in this way varying the steady current set up on the line by generator G. So there were set up the two desirable features for the production of modulated high-frequency carrier waves capable of translation into audible speech

(To be continued.)

A FIRE TEST.



A fire which occurred in the Finished Stores at the Ponders End Works of the Edison Swan Electric Co., Ltd., some little time ago, served, in a measure, to accentuate the robust qualities of the "Little Glutton" Vacuum Cleaner which is manufactured by the Company.

The machine illustrated was one of several which was stored in the building which was completely destroyed by the fire. Whilst this particular machine did not naturally bear the full brunt of the fire, it was subjected to sufficient heat to melt some of the metal parts, and badly to distort others, and in addition it was saturated by water. On its being placed on circuit it was found that the motor was in quite good running order, and the suction, as recorded on the water gauge, had only decreased by half an inch from that originally recorded when the machine was new.

RADIO TOWERS AND MASTS.

On Wednesday, January 10, a paper was read by Mr. C. F. Elwell before the Institution of Electrical Engineers, on "The Design of Radio Towers and Masts: Wind Pressure Assumptions."

The paper deals chiefly with the question of wind pressure on tall structures, such as bridges, chimney stacks and, of course, in the main, towers and masts erected for wireless purposes. After drawing attention to the various wind pressures per sq. ft. on many types of tall structure, the paper concludes by showing how little accurate information exists on the subject, and how wide are the maximum and minimum limits of wind pressure upon which calculations have been based.

The paper points out the economic waste which can, and apparently does, occur when certain wind pressures are assumed. The question of the variation of wind pressure with altitude was also pointed out, although the figures given apply to altitudes far beyond those of any wireless mast that is ever likely to be constructed.

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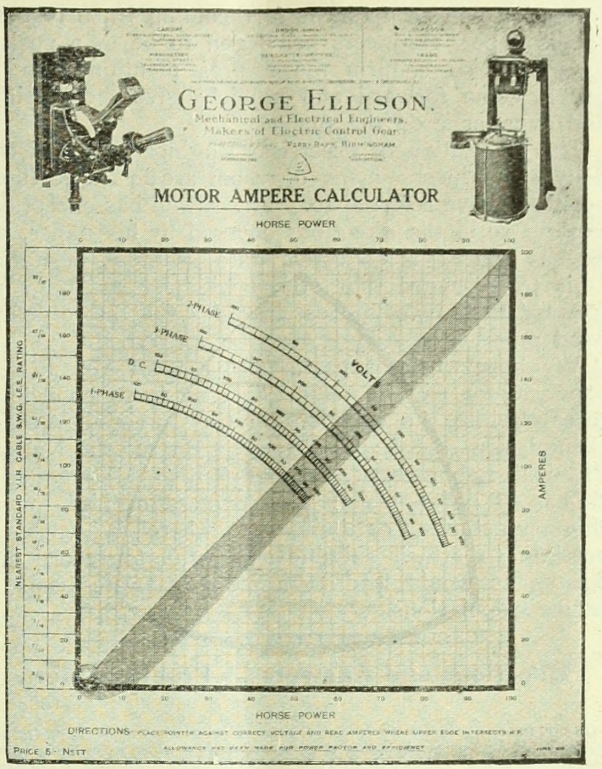
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The whole subject is one on which engineers generally do require more accurate information. Such information will no doubt be forthcoming if, in response to the paper, engineers privileged to be in a position to supply or confirm the figures mentioned in the paper come forward and publicly give their opinion and experience on the subject.

The Institution of Electrical Engineers comprises a body of engineers many of whom are in the fortunate position above referred to. Mr. Elwell has exceptional experience in the directions covered by his paper, and he has given his collective data, without hesitation. It is to be hoped that others will also as freely put forward their own figures, in order that more definite wind pressure standards may be arrived at.

We hope at least that, arising from Mr. Elwell's paper, there will be some effort made to co-ordinate research into the question by the Imperial Wireless Commission, the Radio Research Board, the National Physical Laboratory, and the British Meteorological Office, in collaboration with owners of high masts, chimney stacks, or buildings where it would be possible to attach suitable apparatus to record such figures as would lead to a more accurate basis for future calculations.

Questions and Answers by Practical Men.

RULES.

QUESTIONS: *We invite our readers to send us questions, preferably on technical problems that have arisen in actual practice. Questions which we consider of sufficient interest to our readers will either be replied to under "Answers to Correspondents" or replies will be invited from our readers. One shilling will be paid for the question which we select for competitive replies in this column.*

ANSWERS: *A fee of 10s. will be paid for the answer which we consider shows the greatest merit, and 5s. for the one we select as second best. In judging the replies, importance will be attached to clearness and conciseness, as well as accuracy. The Editor reserves the right to make no award, or to accept only one reply, if, in his opinion, the answers received do not possess sufficient merit. Competitors desiring the return of their manuscripts, if unaccepted, should enclose stamped addressed envelope.*

Write on one side of the paper only, and if diagrams are sent, draw them on a separate sheet of paper attached to the manuscript. Competitors may adopt a "nom de plume," but, both in the case of questions and answers, the competitor's real name and address must be sent with the manuscript as a guarantee of good faith. No correspondence will be entered into with regard to successful replies. The Editor's decision is final.

Commencing with Question No. 101, a Diploma of Merit will be awarded to the six competitors who win the first or second prize the most times during the next twelve months.

The words "Questions and Answers" or "Q" and "A" should be placed at the top left-hand corner of all letters intended for this column.

QUESTION NO. 153.

Is the old Marconi coherer suitable for wireless telephony receiving sets? If so, how can I adapt it for this purpose?—"B.B."

QUESTION NO. 154.

I have a new accumulator enclosed in a celluloid case. Its capacity is 50 ampere hours. I notice that sulphating has commenced to take place, not on the plates, but on the bars which hold the plates together. Is this injurious? If so, how can I prevent it?

—"PAX."

(Replies to Questions 153 and 154 must be received not later than February 10, 1923.)

Panama and Costa Rica.—The report on the Economic and Financial Situation in these Republics has just been issued by the D.O.T. (1s. 8d., post free). There is little of direct electrical interest therein. Most of this trade is in the hands of United States firms, but it is stated that the electric lighting charges in Panama are exorbitant. Certain extensions have been made to the submarine cables on the coast, but broadcasting to private wireless telephones has been discontinued owing to the confusion caused to the Naval Radio Stations.

REGISTRATION OF ELECTRICAL CONTRACTORS.

A voluntary scheme of registration of electrical contractors has been approved by a committee set up by the Institution of Electrical Engineers, and invitations have been issued to the constituent bodies of this committee, as under, to nominate representatives should they desire to be represented on the registration authority:—

The Institution of Elec. Engineers.
The Elec. Contractors' Assoc. (Inc.), including North Ireland.
The E.C.A. of Scotland.
The Elec. Contractors of the Irish Free State.
Royal Inst. of British Architects.
Provincial E.S. Companies of the U.K.
Incorp. Municipal Elec. Assoc.
Incorp. Assoc. of Electric Power Companies.
Conference of Chief Officials of London E.S. Companies.
Assoc. of Consult. Engineers.
British Elec. Develop. Assoc.
B.E.A.M.A.
Fire Offices Committee.
Elec. Wholesalers' Federation.

HYDRO-ELECTRIC PLANT IN NEW SOUTH WALES.

The Sydney *Daily Telegraph* of November 24 contains some particulars of the Dorrigo hydro-electric scheme, the first of its kind to be completed and put into operation in the State of New South Wales. The main details and specifications were planned by Mr. Wm. Corin, M.I.C.E., chief electrical engineer to the Department of Public Works, N.S.W., and the major portion of the plant installed was supplied by Messrs. W. G. Armstrong, Whitworth and Company, Limited. Two turbo generators are installed, each of 100 kw. (150 h.p.) capacity. They supply current at 2,300 volts, which is transmitted above two miles to Dorrigo township, and there transformed for use in lighting the town and supplying the butter factory and town with power. The scheme is laid down with the idea of extension.

Calendars.—The calendar issued by the British Ebonite Co., Ltd., of Hanwell, London, W. 7, gives six decidedly humorous illustrations in colour of the "Monarchs of England" from Alfred the Great in his mother's arms to Charles I. receiving his first rattle from father. It is certain to be appreciated by all who are so fortunate as to receive a copy.——We have to thank our esteemed contemporary, the *Financial News*, for a useful season-ticket case and calendar for the current year. It has been put into use forthwith.

NEW BOOKS PUBLISHED.

"The Golden Hammer and Other Engineering Stories," by A. W. Marshall. Cl. 8vo, 188 pp., illustrated, 3s. 6d. net.
"Arithmetic for Engineers," by C. B. Clapham, 3rd edition. Cl. 8vo, 491 pp., illustrated, 7s. 6d. net.
"Text Book on Wireless Telegraphy." Vol. II., Valves and Valve Apparatus, by Rupert Stanley, 2nd edition. Cl. 8vo, 394 pp., 249 illustrations, 15s. net.
"The Elementary Principles of Lighting and Photometry," by J. W. T. Walsh. Mm. 8vo, cloth, 220 pp., 85 illustrations, 10s. 6d. net.

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Reviews of Books, &c.

[Books noticed in this column will be sent from ELECTRICITY *Office to any part of the world, for the published price, plus ten per cent. for postage (minimum 2d.) and orders will be appreciated.]*

ARITHMETIC FOR ENGINEERS. By C. B. Clapham. Third Edition. Demy 8vo, cloth, 491 pp., 174 illus. (Chapman and Hall, 7s. 6d. net).—It has already been our pleasure to review two editions of this textbook, and the demand for this third edition is simply due to the inherent excellent qualities having caused it to sell out more rapidly than was anticipated. The addition of a chapter on Elementary Trigonometry has naturally made it even more valuable to students in technical schools, with whom it is certain to continue in high favour, as well as to enterprising workers who wish to master thoroughly the elementary figures which form such a necessary portion of all present-day engineering and electrical problems and construction. The printing and illustrations are remarkably clear, and there is a wealth of exercises which the student can practise upon. The book is sure to sell well.

LUBRICATION AND LUBRICANTS. By J. H. Hyde. Cl., 114 pp., 37 illus. (Pitman, 2s. 6d. net.).—This is another of the useful practical primers which are being published under the supervision of Mr. R. E. Neale, and it gives in a concise form much useful information on the theory and practice of lubrication, written and illustrated in a way which will render it of direct value to engineers, chemists and students. The physical, chemical and mechanical properties and testing of liquid and solid lubricants are dealt with in a clear and explanatory manner, and, in addition, there are notes on recent developments, with examples from actual practice, which add materially to its use to the electrical engineer in charge of moving plant.

Correspondence.

CAN ANYONE EXPLAIN?

From the replies received in connection with the query raised last week by "Cine-Car," we have pleasure in publishing the following reply. Other replies will be published later.

To the Editor of ELECTRICITY.

DEAR SIR,—The phenomenon observed by your correspondent, "Cine-Car" on the kinema screen may be explained by reference to a well-known piece of apparatus, called a stroboscope. It may consist of a disc upon which are drawn sectors, alternately white and black. When rotated at speed and viewed by an intermittent light, the sectors appear to be either stationary, or to rotate, backward or forward.

The stationary effect is produced as follows: A black sector, say, is observed; for an interval light is cut off, and if within this interval another black sector has moved into a position previously occupied by the other, the appearance on the eye is stationary. For by virtue of the Persistence of Vision, during the interval that light is off, an image of the black sector is retained by the retina, so that when light comes on again, and another sector in place, the effect upon the eye is the same as if the sector had not moved at all.

If now the disc turns slower, each sector has not moved far enough before light is on again, and another sector is seen just behind previous one, which gives an impression that disc is rotating backwards.

Similar conditions prevail when the kinematograph machine is taking a picture of a moving car with wheels. The latter taking place of our stroboscopic disc, while the shutter of camera performs the intermittent action. The results being repeated later upon the screen.

The results can easily be verified experimentally. The disc might have, say, 32 sectors, and a diam. of perhaps 12 inches. A fairly bright light enclosed within a box having a small aperture, up to 1 inch, and a disc having two holes of same size, on opposite sides, pivoted to rotate in front of aperture, so that holes may coincide; this will provide a source of intermittent light when rotated. To get the effects, the speed of either the disc, or of the light interruptions, may be varied. There are limits, however, and both should be able to run up to a fair speed. Full particulars of the stroboscopic disc will be found in any good textbook of physics.—Yours faithfully,

L. E. SULSTON.

"Tremore," North Road,
Aberystwyth.

Trade Notes.

A delightful series of electric light fitting folders, for overprinting contractors' names and addresses, has been produced by the **British Thomson-Houston Co., Ltd.** (Mazda House, Upper Thames Street, E.C.4). The folders are eight in number, and deal respectively with hall lanterns, wood pendants, brackets and standards, drop pendants, dining-room pendants, bedroom pendants, wall brackets, standards, and electroliers.

Attention is being drawn to a range of British-made electric tools of British design placed on the market by **Cooper and Smith, Ltd.** (110 Cannon Street, E.C.4). The tools comprise various light-weight portable drills, tool post grinders, grinding, polishing and buffing machines, blowers, syrens, etc., while there is a range of small power motors with separate bases so that they may be adapted to the peculiarities of different drives. There is also a valuable adjunct to motor garage equipment in the small portable light-weight motor with leather sling for carrying. By its use motor-cars can be polished and cleaned quickly. It can also be used in many instances in the household.

Transformer users and recipients of that most excellent mine of information, "Transformer Abstracts," will be glad that **Johnson and Phillips, Ltd.** (Charlton, S.E.7), have now published a comprehensive index to enhance still further the value of this work, which, it will be remembered, was recently issued in 12 parts.

Messrs. G. H. T. Petersen (Engineers' Merchants), Ltd., of 82, Victoria Street, London, S.W.1, announce that the selling prices of the "FORS" accumulators will be increased as from February 1, 1923.

A revised list of prices of mechanical and electrical apparatus directly connected with lifts, cranes, hoists, conveyors, etc., has just been issued by **Marryat and Scott, Ltd.**, of 28, Hatton Garden, London, E.C. 1. The new prices show considerable reductions and will doubtless be much appreciated by their numerous clients.

Electric furnaces and pyrometers are dealt with in a well-illustrated and comprehensive list just issued by **Baird and Tatlock (London), Ltd.**, of 14, Cross Street, Hatton Garden, E.C. 1. It will be of direct interest to all readers who are in any way associated with the use of such furnaces, muffles, etc.

"Domestic Electrical Appliances" is the title of a new 20-pp. illustrated list just to hand from the "**Sunco**," of 118, Charing Cross Road, London, W.C. 2. It gives clear details, prices, etc., of the wide range of irons kettles, teapots, toasters,

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boiling rings, cookers, sewing-machine motors, and other items which can be correctly called "domestic," and it should be of value to all factors, contractors and dealers in electrical supplies throughout the United Kingdom. With it were enclosed folders describing the "Sunshine" vacuum cleaner, the "A.B.C." electric laundress, the "Premier" heaters and irons, and the "Falco" domestic cooker, in all of which good trade should be done by energetic readers who are really anxious to push the demand for "juice," especially in view of the fact that considerable reductions have been made in the prices.

Catalogue No. 48 of accessories and specialities for the automobile and electrical trades has just been issued by **A. H. Hunt, Ltd.**, of the H.A.H. Works, Tunstall Road, Croydon, Surrey. It contains illustrations, details and prices of such well-known items as the "Sunlite" portable dry-battery hand lamp, Hellesen H.T. wireless dry batteries, pedal-cycle lighting sets, H.A.H. insulating tape, etc., and will no doubt interest a very large number of our readers. Dealers in such goods should write for copies without delay, so as to prepare for the coming season.

Users of terminals for electrical instruments and apparatus, as well as for electrical work generally, will be interested in the new type which has just been placed on the market by **Messrs. J. J. Eastick and Sons**, electrical manufacturers, of 2, St. Dunstan's Hill, London, E.C. 3. The lower portion can be used to grip the two tags from the terminals; furthermore, wires can be taken to the hole in centre of terminal, and the hollow binding screw will take $\frac{1}{8}$-in. pin, this being the size of the split pins used for valve legs. In addition, there is a recess cut on the body of the terminal, which takes the makers' standard clip connectors. They are being put on the market at a very modest price, and interested clients should make a point of writing to the makers and obtaining full particulars.

A neat, well-printed folder price list of Sceando drawn-wire lamps has just been issued by **Messrs. Crowther and Osborn**, of 7, Blackfriars Street, Manchester, and should be obtained without delay by all contractors, factors, and regular users of incandescent lamps of any type. The Sceando make is used by such important undertakings as H.M. Office of Works, the General Post Office, L. and N.W.R., N.E.R., S.E. and C.R., G.N.R., Met. R., G.C.R., Orient Steamship Co., etc., and this is, of course, a splendid testimonial of its quality and efficiency.

Various Items.

Annual Dinner.—The annual dinner of the Scottish centre of the I.E.E. will be held on Monday, March 5, at the Station Hotel, Gordon Street, Glasgow. Tickets and particulars from Mr. W. E. Winning, 166, St. Vincent Street, Glasgow.

Publicity.—The Sterling Telephone and Electric Co., Ltd., have appointed Mr. V. Sinclair to take charge of their publicity department. Mr. Sinclair's abilities in this direction are well known to a very wide circle in the technical and trade Press, and we shall look forward to developments in the business of this important undertaking.

Production.—A general meeting of the Inst. of Production Engineers will be held at 7.30 p.m. on Friday, 26th inst., at the Engineers' Club, Coventry Street, London, W.1, when Mr. W. Attwood, M.I.P.E., will present a paper dealing with "The Principles of Organisation and Management." All interested are invited to attend, whether members of the Institution or not, and no tickets are necessary.

Meetings.—The Junior Inst. of Engineers will meet at 39, Victoria Street, Westminster, S.W.1, on Friday, 26th inst., lecturette, "K.V.A. and its Measurement" (demonstrations), by G. F. Shotter; also on Friday, Feb. 2, lecturette, "Ventilation and Lighting of Factories" (slides), by P. J. Waldram; and on Friday, Feb. 9, lecture, "The Effect of Temperature on the Properties of Engineering Materials," by Prof. F. O. Lea, D.Sc. (slides). All at 7.30 p.m.

Peru.—The Report on the Finance, Industry and Trade of Peru has just been issued by the Dept. of Overseas Trade (price 1s. net, post free), and will be read with interest by merchants and manufacturers who wish to open up trade with that country. Apparently German goods are appearing in the market in increasing quantities, including a considerable quantity of electrical appliances. We can quite expect that some are of the usual cheap type. It is, however, to be hoped that English firms will do their best to maintain and extend their trade in this country. The situation appears to be improving.

Meetings.—The I.E.E. will meet on Thursday, Feb. 1, at 6 p.m. Paper: "The Maintenance of Voltage on a D.C. Distribution System by Means of a Fully Automatic Sub-station," by P. J. Robinson.

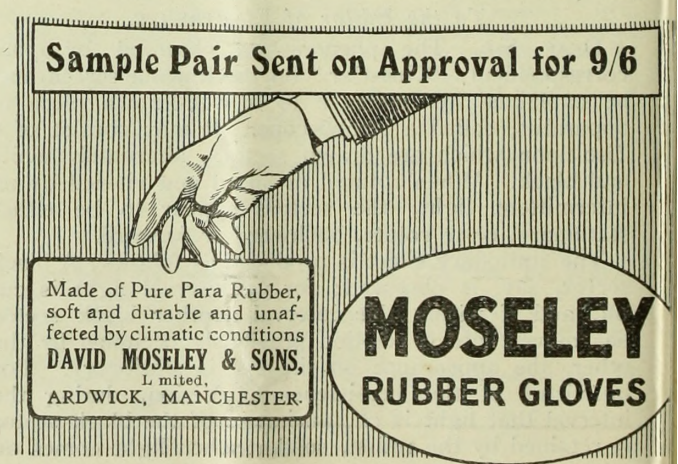
Personal.—Lord Monk Bretton, C.B., has found it necessary to resign his membership of the L.C.C. Committee on London Electricity Supply, and it is proposed that Mr. W. E. Marchant, O.B.E., be appointed a member in his place.

Working Drawings.—Mr. Claude E. Mayer, engineer, of 18, Geoffrey Road, London, S.E.4, who has had eighteen years' workshop and drawing office experience, is open to undertake private draughtsmanship and design work. He invites inquiries.

"**Exercises in Electrical Engineering.**"—This is a book by Prof. Magnus Maclean which contains a large amount of practical information in an educational sense, and has proved of great value to many young electrical engineers who have made use of it when working up for higher positions in the industry. The price is only 1s. post free from ELECTRICITY office.

"**Radio Telephony for Amateurs.**"—This is yet another addition to the list of books for people who are suffering from a bad attack of the prevailing epidemic. It is quite a big book of 296 demy 8vo pages, with 153 beautifully printed illustrations, well bound in cloth, and the price is only 8s. post free from S. Rentell and Co., Ltd. (ELECTRICITY office), 36, Maiden Lane, London, W.C.2. A review will appear in an early issue.

Tenders Invited.—The State Electric Light Works of Montevideo invite tenders for 1,500 electric meters for direct current and accessories, and also 8,500 electric meters for alternating current and accessories. Specifications (in Spanish) can be seen by British firms at the D.O.T. (Room 49), 35, Old Queen Street, London, S.W.1.——The public Works Department, Wellington, New Zealand, invite tenders for the supply and delivery of 110,000 volt insulators, in connection with the Mangahao Electrical Power Scheme. Specifications can be seen by U.K. firms at Room 49, as above.——The Victorian Commissioners invite tenders for the supply and delivery of twenty-five dwarf electric signal mechanisms (Contract No. 35,457). Specification can be seen by British firms at the D.O.T. (Room 49), 35, Old Queen Street, London, S.W.1.——The Ministry of the Interior, Prisons Department, Cairo, invites tenders for the supply of electrical goods, tools, machines, lathes, etc., for the year 1923-4. Specifications may be inspected by interested U.K. firms on application to the D.O.T. (Room 84).——The P.W.D. at Wellington, N.Z., invite tenders for the supply and delivery of 110,000 volt switchgear for the Mangahao electric power scheme and for lightning arresters. Specifications at the D.O.T. (Room 49).——Tenders are invited by the Municipal Council of Port Elizabeth, South Africa, for one 3,000 kw. turbo alternator. Specifications can be inspected by interested British firms at the D.O.T. (Room 49), 35, Old Queen Street, Westminster, S.W. 1.——The Chilean State Rys. invite tenders for the supply of electrical material in general for an approximate value of 800,000 pesos. Particulars regarding the above may be seen in Room 84 of the D.O.T. Also at Room 49 particulars may be obtained of a three-phase transformer required by the same State department.——Tenders are also invited by the State Electricity Supply Works at Montevideo, Uruguay, for 66,000 metres of high-tension cable and accessories. Specification at Room 49, 35, Old Queen Street, S.W. 1.



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A POPULAR SCIENTIFIC WEEKLY JOURNAL
ELECTRICITY
A PRACTICAL TRADE JOURNAL

FEBRUARY 2, 1923.

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THE MORKRUM TYPEBAR PRINTER UNIT.*

This machine is a radical departure in construction from the previous Blue and Green Code printer units which have been in service on the Morkrum Company's printing telegraph systems since 1910.

While all the older printer units of the Morkrum Company have been typewheel printers, the new instrument has typebars, an L. C. Smith type-basket being used as well as that typewriter's method of shifting the type-basket in place of the platen.

Among the important improvements in the new typebar unit are the following :—

There are no contacts.

Only six magnets are used, five for the selectors and one for the sixth pulse.

The machine is motor driven, a cam shaft handling all the operations. This shaft and most of the other portions of the printer which move bear in bronze bearings, which in turn rest in saddles in the castings.

All parts are readily removable by taking out four or five screws, each group of actions coming out as a unit.

Practically all screws are of the same size and thread, except a few of the bearing screws.

The oiling system is perhaps unique in this class of apparatus, the shafts being hollow and are made to act as reservoirs for oil for the bearings which carry the shafts. Enough oil can be put in the various parts of the machine to lubricate it thoroughly for several weeks.

The platen of this machine slides on a square shaft which passes through the platen and is held at each end in projection from the cast top of the machine. This square shaft can be rotated, and, as it does not move longitudinally, only the platen moving, the lining action can be placed at the right-hand end of the shaft, and rotate it by means of a pawl and a toothed wheel. The fixed position of this square shaft makes it very easy for an operator to reach out and feed the blanks at any point in the movement of the platen. It is particularly valuable where it is necessary to feed stencils, books and forms.

When signals are received in the five selector magnets of the printer from whatever form of distributor, the magnets operate a selector similar in construction to that used in the Morkrum Green Code printer units, though the parts differ in form.

The code bars having been set by the selector, the sixth pulse magnet throws a toothed clutch into engagement and the main cam shaft starts to rotate, receiving its motion from the motor. A detent holds the code bars in position after selection. These code bars are notched in the lower sides and are five in number. An instant after the cam shaft starts to rotate the selectors are reset, and are ready for the next selection.

Cam action causes a bail to rise and allow the push bars, attached to the various typebars, to press against the lower sides of the code bars. One of these code bars finds a series of slots which allows it to rise higher than the rest of the push bars and directly into the path of a bail known as the striking bail.

The striking bail normally held away from the path of any push bar is released by the rotation of the cam shaft and under the tension of a spring swings forward and pushes the push bar at that moment in its path and causes the typebar attached to the latter to strike the platen. The blow of the striker bail is adjustable.

The same method of operation is used with the functions of the printer, such as line feed, shift, release, etc., however, an extra cam surface is provided on the cam shaft which assists the action of the striker bail spring if the load is too heavy for the spring and this power is only applied when a heavy load such as a function demands it.

The completion of the rotation of the cam shaft releases the code bars and resets all the bails to their resting position.

The spacing of the platen is taken care of by a cam operated spacing pawl which acts on a toothed wheel driving the platen through a pinion and rack. There is no possibility of letters piling up, either by accident or design, as the spacing action is so strong it is impossible to hold the platen still. The smooth, steady forward movement of the platen when spacing makes it easy to read copy while the machine is in operation, there being no dazzle due to jerky spacing.

This printer unit can be used with the new Morkrum direct keyboard sets, with single channel duplex Morkrum sets and with Multiplex sets.

An interesting point about the use of motor drive in the printer is the fact that complete sets are being built which are connected directly to alternating current sources of supply, and require so little direct current for operation that it can be supplied by a motor generator with a power output of 15 watts, this generator being small enough to mount on the operating table in a case.

* *Telegraph and Telephone Age*, New York.

Preliminary Notice.—The third annual general meeting of the British Electrical Development Association, Incorporated, will be held at the Hôtel Cecil, W.C. 2, on Friday, March 16, at 12 noon, and will be followed by the annual luncheon of the Association at 1 p.m.

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"WIRED WIRELESS"—LINE RADIO.*

By Major J. A. Mauborgne, United States Signal Corps.

(*Continued from page* 46.)

Modulation.

Telephony is accomplished by altering the amplitude of the high-frequency wave in accordance with the speech wave at the transmitting end, and at the receiving end the wave is rectified by some type of detector, so that its varying amplitude is reproduced as a speech wave. If very high carrier frequencies are employed, one distinct advantage which results from their use is the elimination of the speech distortion so common to long-distance wire telephony.

In accordance with radio telephonic theory, three frequencies will be present in the telephone line if the modulating frequency contains no harmonics—respectively, the main carrier frequency and the sum and difference of the main carrier frequency and the modulating frequency. If harmonics are present in the modulating frequency, then, in addition to the three main frequencies, there will be additional frequencies corresponding to the sums and differences of the main frequency and each of the harmonics.

Assuming that the fundamental frequency of the voice is 800 cycles per second and the limiting harmonic is 2,000 cycles per second, it is readily seen that, at a high carrier frequency, the band of frequencies which is transmitted is so small a percentage of the main carrier frequency that the attenuation to all frequencies within the band is practically the same. The elimination of speech distortion, due to this cause, thus automatically results. On the contrary, if we employ a carrier wave with a frequency of 10,000, we shall have all frequencies from 8,000 to 12,000, and the tuning of the transmitter, if sharp, will cause very unequal treatment and consequent distortion of the speech at the receiving end.

Hence, sharp tuning with long carrier waves or low frequencies is impracticable, and recourse has to be made to "filters," to separate the various channels when, for extremely long distances, we employ the lower frequencies to avoid very high attenuation. In actual practice, the frequencies employed in multiplex telephony over the long lines are of the order of 10,000, 15,000, 20,000 and 25,000 cycles, and with such low frequencies or long wave lengths elaborate "filter" circuits, such as those devised by J. A. Campbell, of the Western Electric Co., or K. W. Wagner, of Germany, must be used.

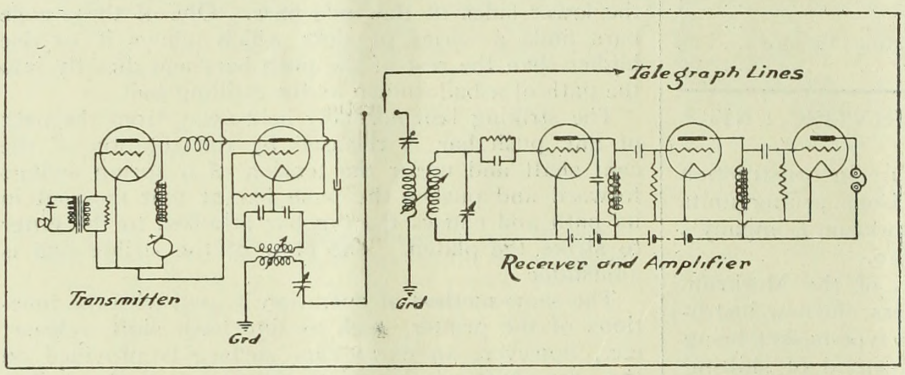


Fig. 3. Circuit Used in Experiments with Line Radio Over Telegraph Line Between Washington and Baltimore.

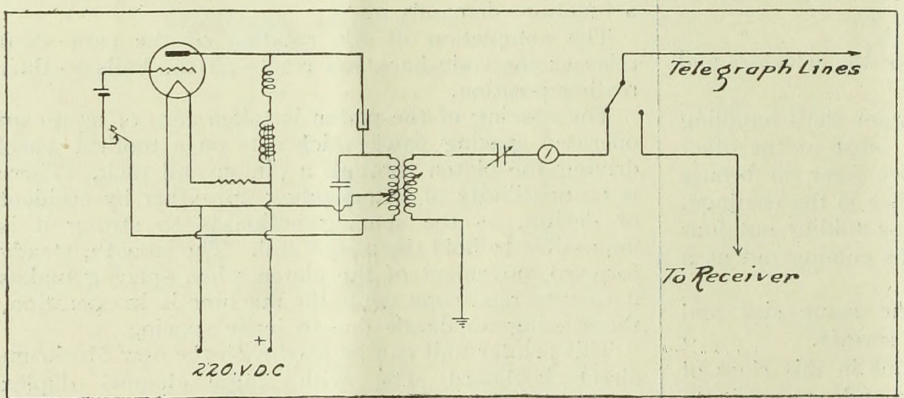


Fig. 4. Experimental Line Radio Circuit for Telegraph Purposes Only, Using a Vacuum Tube Operated from 220-Volt Direct Current Lighting Circuit.

Unless the distances to be covered are such that extremely long wave lengths or low frequencies must be used, the necessity for the filter circuits disappears, and we are free to resort to the original system, using short waves according to General Squier's original method. We shall now direct our attention to some modern circuits employed by the Signal Corps, in which short waves are employed to cover considerable distances, and in which no "filter" circuits are employed.

In the early part of 1919 experiments were conducted by the Signal Corps on a wire belonging to the Postal Telegraph Co., running between Washington and Baltimore, a distance of 66 wire miles. The line was aerial throughout the distance of transmission, and contained a single section of overhead cable approximately one-fourth of a mile in length. In the experiments, the transmitting and receiving apparatus was connected between the line and the ground. The circuit diagram is shown in Fig. 3. The carrier frequency employed was 600,000 cycles per second, corresponding to 500 metres in wave length.

Throughout the entire tests the telegraph line was in ordinary duplex telegraph operation. No interference from the ordinary telegraph operation or from the "wired wireless" was experienced by either system. The normal range of the apparatus, known to the Signal Corps as radio telephone set SCR-67-A, when functioning as a radio telephone on an ordinary antenna, in communication with similar apparatus, is

* *Telephony*, Chicago.

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ten miles; hence it is seen that by means of wired radio the range of communication with the same transmitter was increased many times.

For telegraph purposes only a vacuum tube was employed for operation from a 220-volt, direct-current lighting source. A diagram of the apparatus is shown in Fig. 4.

Results of these preliminary experiments were of unusual interest, as it was demonstrated that transmission over relatively great distances could be accomplished with frequencies greatly in excess of the value which had heretofore positively been considered as the upper limit. It is to be noted that in adjustment of both the transmitting and receiving apparatus, the lines were tuned to resonance by means of a series line capacity. The tuning, while not as sharp as that obtained with a radio antenna, revealed a distinct resonance point, and could be made broad or sharp at will by altering the magnitude of the loading or coupling inductance.

Later experiments conducted by the Signal Corps over the lines of the New York Central Railroad, commenced in the latter part of 1919, developed many other valuable features which have been recorded in the paper by R. D. Duncan, jr., "Recent Attainments in Wired Radio." In this case telephonic and telegraphic communication was established over a pair of wires from Elmsford, N.P., just north of New York City, to Albany, N.Y., a distance of 130 miles.

A good quality of speech and both continuous wave and buzzer modulated telegraph signals were obtained. The carrier frequency varied from 600,000 to 300,000 cycles per second (wave length 500 to 1,000 metres). The high-frequency power output varied from less than ½ watt to 20 watts, depending upon the apparatus used. The receiver employed a detector and two stages of audio frequency amplification.

In the Washington-Baltimore experiments, as well as in the later experiments of the Signal Corps, evidence of the existence of standing waves on the telephone lines was obtained. Standing waves, as is well known, are produced by reflection from either the far end of the line or from intermediate points where there occurs a sudden transition in the electrical properties such as produced by the introduction of short lengths of cable or changes in the size of the conductor.

In the latter case, unless the reflection is complete, a portion only of the outgoing wave will be turned back and a portion will proceed unreflected. As a result there will occur partial reflected and partial unreflected transmission.

The location of the receiving apparatus with respect to the transmitter, when standing waves are present, is therefore determined largely by the wave length or frequency of the carrier wave, since for efficient reception it is necessary to avoid both voltage and current nodes. It was found that altering the frequency at the generator terminal apparently did not produce an effect in moving the nodes and loops along the lines equivalent to that of moving the receiving apparatus.

(To be continued.)

British Turbine for Chicago.—C. A. Parsons and Co., Ltd., have received an order from the Commonwealth Edison Company for a 40,000 kw. turbine to be installed in the new Crawford Avenue power station.

SOME NOTES ON METERING THREE-PHASE POWER SUPPLY.

By G. W. STUBBINGS, A.M.I.E.E., A.INST.P.

The large number of consumers whose demand for power is of the order 100-200 kw. supplied on the three-phase system, renders the question of metering one of importance. In the case of larger undertakings methods of metering three-phase supplies are standardised, but a review of the available methods may be interesting to those connected with the smaller undertakings in which individual demands for over 100 kw. of three-phase power are uncommon.

In the first place it must be noted that the question of the cost of metering equipment is of much less importance in the case of a large consumer than in that of the small domestic load. In the latter case the cost of the meter is often of the same order as the amount of the yearly revenue, whilst in the case of the large power consumer the cost of the metering equipment is relatively trifling. It follows therefore that, whereas in the case of the domestic consumer it may be a good proposition to sacrifice extreme accuracy and use a cheaper meter, this does not apply with large power supplies, when no money should be spared to obtain permanent and high accuracy, ease and simplicity in testing and connecting.

The various methods of metering may next be considered in detail. The most obvious and usual method is by the use of a polyphase induction meter. Since private supplies are, or ought to be, metered on the low-tension supply when the service mains are high tension, two current transformers are all the additional apparatus required. The advantages of the polyphase meter are that it gives a direct record of the consumption and that it is the cheapest. Polyphase meters are, however, difficult to test within narrow limits of accuracy, especially so when operated with series transformers. Mistakes can also be made in connecting up which may seriously impair the accuracy of registration. These defects require serious consideration, especially in the smaller undertakings where the testing facilities are not very good, and such defects have been largely instrumental in securing wide adoption of other methods which, if not so advantageous as regards initial cost, yet give promise of more prolonged accuracy.

The polyphase meter consists of two single-phase elements assembled in one case, each element driving a single rotating member. An obvious alternative to the use of this instrument is to use two separate single-phase meters. The advantages of such a system are very considerable. The single-phase meter has a higher inherent accuracy than the polyphase instrument in that it has a lighter rotor. Each meter, moreover, is immune from the influence of the other, this not being the case with the two-element meter, in which interaction between the two elements is a source of error. There is far less chance of wrong connections with two single-phase meters, as forward rotation should be obtained in both meters on lagging power factors down to 0.5. If the meters are accurately adjusted for quadrature, either can be connected in the leading or lagging phases indifferently.

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A good approximation to the average power factor can be obtained from the ratio of the readings (m), if the circuit is fairly balanced, from the formula :—

$$PF = \frac{1}{2} \cdot \frac{m + 1}{\sqrt{m^2 - m + 1}}.$$

Alternatively, if the average power factor be known approximately, the total consumption can be estimated should one meter fail.

The disadvantages of the two-meter method are the higher cost, and the fact that unequal records are obtained on the two meters for inductive loads. This latter circumstance has been found to raise doubts in the minds of consumers as to the accuracy of the meters, it being assumed that the meters should show equal consumptions. Regarding the question of cost, it may be noted that with the two-meter method one single-phase meter would be carried spare for each polyphase meter where these were in use.

It is hardly necessary to say that each meter of a two-meter combination is tested as a single-phase instrument, whereas this procedure is not legitimate with a two-element meter unless special precautions are taken. On the score of ease of calibration there is a very great advantage with the two-meter method, and the cost will be under 50 per cent. greater than that of the two-element meter scheme.

The disadvantage of unequal registrations on the two dials of the two element method that has been referred to above has been responsible, on some undertakings, for the use of three single-phase meters for large three-phase supplies. These are designed for the star voltage, the potential coils being connected Y fashion, the star point being joined to the low tension neutral if this be available. It may be noted that it is not absolutely necessary to do this as the combination will meter correctly with a free neutral. By using three meters approximately equal records are obtained on each instrument, the method is fairly self-checking, forward registration is obtained at all power factors, and if the star point is connected to the supply neutral the combination is accurate for unbalanced four-wire lighting loads. Although the cost is certainly higher than each of the foregoing methods, the registrations are much more satisfactory from the consumer's point of view. To secure maximum accuracy three series transformers should be used, each meter being calibrated in conjunction with its own transformer. The three series transformers will be interconnected four-wire on the secondary side.

The foregoing notes will serve to emphasise the fact that the cheapness of the polyphase meter is largely discounted by attendant disadvantages ; and the benefits of the two- or three-meter methods are commended to those connected with small undertakings, in which ease of calibration and installation will probably be found an ample set-off against the slightly increased initial cost.

Tenders Invited.—South Africa reports that the Corpn. Electricity Dept., Cape Town, invite tenders for the supply and delivery of a two-phase oil insulated, air-cooled induction voltage regulator, together with a tank operating gear and the necessary quantity of oil. The regulator is for use for a system of supply of 2-phase, 4-wire, 2,450 volts, 50-periods. The regulator is to be arranged for motor operation, the operating motor to be 220 volts D.C. Specification can be inspected at the D.O.T (Room 49), 35, Old Queen Street, S.W.1.

THE PHYSICAL SOCIETY'S EXHIBITION.

The exhibit of the Record Electrical Co., Ltd., at the recent exhibition promoted by the Physical Society, attracted a good deal of attention, as they had a number of novelties and new instruments on their stand.

The most novel instrument was a moving iron instrument invented by Mr. J. W. Record. This instrument, adaptable either for an ammeter or a voltmeter, consisted of two coils, one above the other, the lower coil containing a fixed iron and a spindle provided with a movable iron exactly similar to the ordinary repulsion moving iron instrument. Instead, however, of the pointer being attached to the spindle, an arm was extended from it into the coil above, which arm carried a piece of iron. A second spindle in the upper coil carried a piece of iron, and the pointer, the combination being practically two simple moving iron systems one above the other. The fixed iron in the lower coil repels the moving iron adjacent to it. At the same time the two irons in the upper coil are repelled from one another, but as the pointer carrying iron is deflected, it is followed by its adjacent repelling iron, consequently for every one degree deflection of the lower moving iron, the pointer deflects 2 deg., and so on. Finally, when the lower iron has deflected 140 deg. the pointer will have deflected 280 deg. With this arrangement the moving system is very light, and the controlling forces exceptionally strong in proportion to the mass of the moving system. The instrument is primarily intended for alternating current, has a very small frequency and temperature error, and is intended to be a sister instrument to the well-known Record Cirscale moving coil instrument for direct current.

Other instruments of considerable interest were a complete range of Cirscale instruments from 3 in. in diameter to 16 in. in diameter. Included were a number of miniature Cirscale instruments in various patterns for different purposes.

One of these miniature instruments is made up in the form of a pocket test set, the overall dimensions being 6 in. by 4 in. by $2\frac{1}{2}$ in., total weight $1\frac{3}{4}$ lb., the ranges 5 and 50 amp., 5, 50 and 250 volts, all shunts and resistances being self-contained. An extra terminal can be fitted for milli-volts for use with separate shunts. This instrument covers a very large range of testing, is an exceedingly useful instrument for wireless research work, and will be found invaluable for amateurs engaged in experimental work. For wireless work the test set can also be made in the following ranges :—

Volts.	Amperes.
5	25 m/a
50	0.5 amp. (500 m/a)
250	5
	25

A number of Record ohmmeters and generators were also on view. This instrument is now so well-known that any further description is unnecessary, save to remark that we believe it to be the pioneer of the small light inexpensive type of true ohmmeter, and has several novel features, which make the instrument an exceedingly useful and practical piece of apparatus.

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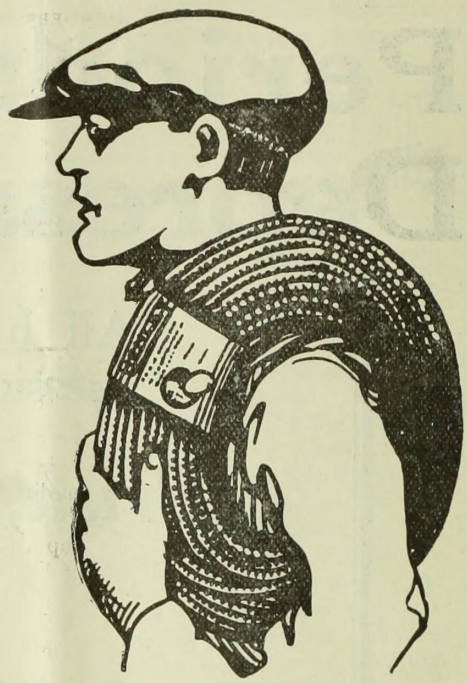
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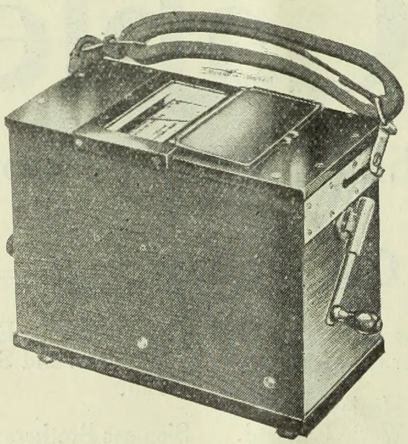
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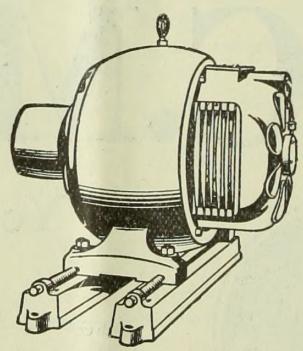
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TO OUR READERS.

ELECTRICITY is published every Friday, and, if ordered, is on sale at the principal Railway Station Bookstalls and Newsagents on that day. It has a very large sale throughout the United Kingdom, as well as in the British Colonies and Abroad.

Questions to which an answer is required must be accompanied by a 1½d. stamp for reply. When considered of sufficient interest, the answer will probably appear in the paper.

New advertisements for the displayed columns and alterations to existing ones must reach the publishing office not later than first post Tuesday morning, in order to be in time for the issue of the following Friday. This is important. Rate quoted on application. Subscription: 13s. a year, 6s. 6d. half year, 3s. 3d. a quarter in advance, postage prepaid in the United Kingdom and abroad.

All remittances payable to the Publishers, S. RENTELL AND CO., LTD., 36 39, Maiden Lane, London, W.C.2. Telephone No. 2460 Gerrard.

Current Topics.

A Chapter of Preventable (?) Accidents.

I am loth to labour the subject of breakdowns in public electricity supply, seeing that such occurrences are far from creditable to the supply industry, but no good can accrue from hushing up these matters, and it is far preferable to ventilate the subject with a view to future prevention than adopt the attitude of the gas interests in regard to the therm and carbon monoxide poisoning, and let public pressure bring about reform. Since I last dealt with this matter there have been no fewer than sixteen further failures of supply of varying duration in different parts of the country, causing incalculable loss and irritation to local users of electricity, and bringing the reliability of supply into serious question. From the bare facts reported in the various local newspapers it would appear that a large proportion of these breakdowns were preventable had due precautions been taken and an efficient system of inspection been in vogue at the stations and on the networks in which they occurred.

Here are a few examples: Barrow breakdown caused by mouse in H.T. switch-box, its charred body was discovered subsequent to the accident. That a mouse should be able to bring about total failure of the electricity supply of a district does not speak well for either the protective system in vogue or the effective sub-division of the network. St. Pancras, turbo breakdown; similar causes are given for the failures at Batley and York respectively, which seems to point to defects in the design of these high-speed prime movers. Incidentally, the Batley failure was a triple one, repeated at intervals, and was in part due to failure of a supplementary bulk supply from the Yorkshire Electric Power Company. Defective cables were responsible for breakdowns at Darwen, Nelson, and Oldham; whilst the drawbacks of street switchpillars and trolley standards were emphasised by supply failures arising out of collisions between these structures and motor vehicles at Ammanford and Acton. Plant breakdowns, of which no details are given, accounted for failures at Huddersfield and Gillingham respectively, whilst another instance of ineffective sub-division of network occurred at Blackburn, where a mill fire seriously affected the supply over an entire district.

Dundee consumers were victims of a short-circuit in a control panel, another case of insufficient isolation between sections, whilst Sunderland has evidently paid insufficient attentions to the foundations of its section boxes, a subsidence having led to failure of the supply there. No explanation is forthcoming as to the cause of the breakdowns at Dover and Walton-on-Naze. Now here is a healthy crop, or rather an unhealthy crop, of experiences simply shouting out for investigation by such a competent body as I suggested should hold inquiries into these cases. There is obviously something very much amiss with public electricity supply in this country, when no fewer than sixteen serious failures in supply can take place in less than one month out of the twelve, and I must confess surprise that those organs of the gas industry, which delight in criticising their greatest competitor, have not seized the opportunity afforded by this tale of successive failures as told in the lay Press. In any event, I have now anticipated them, and I think readers will agree that it is far better this matter should be ventilated in an electrical journal than in one devoted to competitive interests. Now Mr. Station Engineer and Main's Superintendent—What about it?

Side or Centre Standards?

In view of two of the above reported occurrences, the decision of the Marylebone Council to abandon a project for erecting electric lamp standards down the centre of Baker Street is to be commended. In the Ammanford failure, a skidding motor-'bus collided with a street standard, and was the fundamental cause of the trouble; whilst the Acton breakdown was similiarly brought about by a motor-vehicle colliding with and wrecking a street switch-box. A case reported in the *Hackney and Kingsland Gazette* also illustrates the ever present danger to traffic and supply alike, arising from the practice of erecting standards along the centre of a thoroughfare, thus reducing its useful width. It seems that two or more arc-lamp standards in Cazenove Road were subjected to collisions by taxi-cabs. A driver of one of the vehicles collided with the second standard with such force that the upper portion fell with a crash, narrowly missing the occupants of the cab and causing the main circuit of Cazenove Road to be interrupted, thus extinguishing the whole of the remaining lamps.

Before the arrival of emergency lamps and a repair gang, a second taxi-cab, travelling in the opposite direction, demolished another central standard. Running into darkness, its driver had sought safety in the centre of the roadway, where one would normally expect freedom from obstruction; but as a result of which he collided with a structure which, as I have endeavoured to illustrate, was located in the wrong place, viz., the centre of a busy thoroughfare. Further, on investigation, evidence of yet a third collision was found at the base of another standard, fragments of a broken wind screen, and paint scratches on the pillar showing that a third vehicle had fallen a victim to the dangerous centre standard. Nor are these by any means isolated cases, and a detailed analysis of street accidents throughout our centres of population would probably show an overwhelming case for the abolition of this practice of encroaching upon the traffic area of any busy thoroughfare.

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Cheap Current for Shop Window Lighting.

The vogue of leaving shop windows illuminated after closing hours is now being encouraged by Manchester Electricity Committee, the inducement being a specially cheap rate for juice (1½d. per unit) consumed for this purpose after 5.30 p.m. Liverpool is following suit, and may well kick itself for not having originated the idea in the first instance. There are indications that other provincial supply authorities will shortly offer similar facilities, all of which makes for improved trade and more attractive main streets after dark.

Incidentally, this encouragement of shop-window illumination after business hours is rather a cute move on the part of the supply authorities, more particularly where the same authority is responsible for the street lighting. Not only does it furnish a useful off-peak load for the plant, but at the same time it helps the general scheme of illumination of the main shopping thoroughfares, and should ultimately enable the authorities to dispense with a percentage of their legitimate street lamps during the hours of illumination provided by private enterprise and at the expense of the retail trader.

Power or Lighting Rate —an Anomaly.

A case recently before the magistrates at Bath possesses interesting features, in that it exemplifies current practice all over the country and raises a debatable point. A local firm of electricians were summoned by the Electricity Committee for using current, metered at power rates, for lighting their premises, whereas they should have paid for such current at the full lighting rate. The facts, as brought out in evidence, were that a bank of lamps used as resistance in connection with a battery charging board on the firm's premises were also distributed throughout the workshop and employed in a secondary capacity for lighting. Verdict was given against the firm; but it is an interesting point whether or no lamps used for the purpose of dead or idle resistance in a battery charging circuit could not be legitimately employed for lighting, inasmuch as their normal brilliancy is reduced, and they could obviously not afford sufficient illumination to rank as the sole means of lighting any premises. It is surely preferable to make some use of the otherwise waste current incidental to accumulator charging direct from the mains with a series resistance in circuit, and, since the current has to be paid for in any case, and is legitimately chargeable at power rate, wherein lies the harm? The supply authority suffers no loss, and the consumer gains some slight benefit at nobody's expense. Truly the Law is an Ass when it comes to adjudicating upon technical matters.

Elektron.

Jersey.—The most important item being discussed by the States of Jersey, now in session, is the concession for electric lighting of the island.

Haslingden.—A big building programme is foreshadowed, including new board-room and offices for the Poor Law, new store-rooms, reconstruction of the laundry, and accommodation for the massage centre. The cost will exceed £40,000.

THE EXHIBIT OF EVERETT EDGCUMBE AND CO., LTD., AT THE PHYSICAL SOCIETY'S EXHIBITION.

A great feature was made of instruments illuminated internally and having open glass fronts so as to show clearly the working parts, the well-known "Superscale" ammeters and voltmeters being exhibited in this way, as well as a wattmeter of the dynamo meter pattern, an ammeter based on the induction principle, and an extra high tension electrostatic voltmeter for 60,000 volts (the latter type of instrument is now made for all voltages up to 300,000, and being air insulated is free from frequency and wave form errors, even up to the highest frequencies).

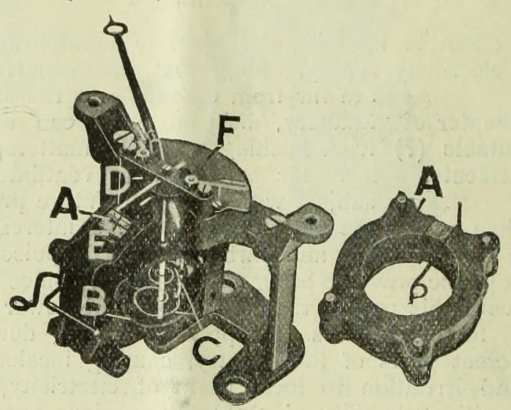


Fig. 1.

In Fig. 1 we show an internal view of an Everett Edgcumbe wattmeter; one of the current coils (A) has been removed for the sake of clearness, (B) is the volt coil, (C) the leading-in ligaments, and (E) the controlling spring.

The weight of the entire moving system is less than 5 grammes, and by means of a very efficient damper (F) the deflection is rendered perfectly deadbeat. These instruments are supplied in switchboard and portable patterns, and are accurate at all power factors, frequencies, and wave forms.

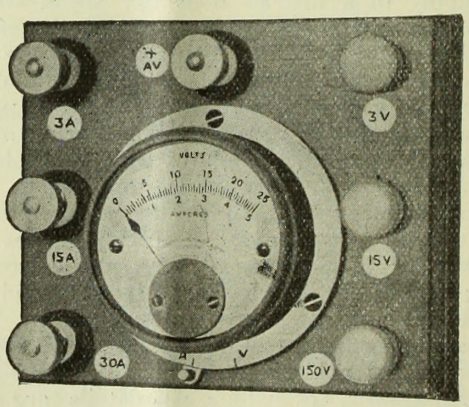


Fig. 2.

A particularly compact testing set, which performs the function of an A.C. ammeter, voltmeter and wattmeter by means of two instruments only, may be mentioned in passing. If only amperes and volts are to be measured a single instrument of half the size only is required. Both these sets are suitable for single-phase or polyphase measurements, whether the loads are

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balanced or unbalanced. For use with these sets, as well as for general A.C. testing work, there is the "Omni range" current transformer, so called from the fact that as distinguished from the usual "multi range" transformers the ranges are almost unlimited in number.

At the other end of the scale, amongst test sets, comes the compact and popular "Dwarf" testing set, illustrated in Fig. 2 (without its leather carrying case). This set, which is particularly useful in connection with wireless receiving sets, has the following ranges :—3, 15 and 150 volts for testing the high and low tension batteries, 1, 5, 3 and 15 amps. for measuring the valve current, and 15 milliamps for measuring the anode current. It fits into a neat plush-lined leather case with snap fastening, measuring overall only $5\frac{1}{8}$ in. by $4\frac{3}{4}$ in. by $2\frac{3}{4}$ in.

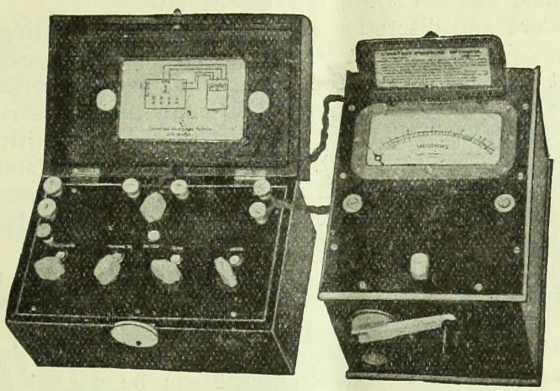


FIG. 3.

Fig. 3 illustrates the recently developed Everett Edgcumbe Metrohm Bridge, which comprises the well-known constant voltage metrohm for 100 megohms at 500 volts, together with a 4-dial direct reading Wheatstone bridge, by means of which resistance measurements can be readily made from the lowest values up to one megohm. It thus fills the gap which is left below the useful range of the metrohm itself.

For bridge measurements the metrohm serves as an extremely sensitive galvanometer. A useful variation which is available consists in a galvanometer and battery self-contained in the bridge itself, and by means of which the latter can be employed independently of the metrohm, which may at the time be in use elsewhere.

In conclusion, we would mention a very "simple to operate" Planimeter, which has proved particularly valuable for use with graphic power factor meters, in connection with power factor correction, or with systems of payment based upon the consumers' power factor. Messrs. Everett Edgcumbe have, as is well known, long specialised in graphic power factor meters, kilo-volt-ampere meters, and reactive component (sine) meters.

Wireless.—The Board of Trade have issued from H.M. Stationery Office a list divided into two parts, giving in Part I. the names of the vessels which have held sea-going passengers' certificates since January 1, 1921, and dealing generally with their classifications under the Wireless Telegraphy Act, and the conditions which they have to comply with thereunder. It should interest all who are anxious to obtain positions on such ships.

NEW EDITION OF "TELEPHONY" BY McMEEN AND MILLER.*

The new edition of *Telephony*, by McMeen and Miller, which was placed on the market the middle of September, is selling like the proverbial hot cakes. Everyone interested in telephone engineering ought to have a copy of this encyclopædia of the telephone. In describing the book, Arthur Bessy Smith, the well-known electrical engineer of Chicago, recently had this to say :—

"This is an excellent general treatise on telephony, a leader of its kind. Within its 925 pages and 682 illustrations the telephone man can find a clearly written discussion of practically every phase of the telephone art. It is good both as a text and as a book of reference."

The arrangement of subjects is logical and therefore easy for the reader to follow. For instance, after a brief historical review, sound and the electrical reproduction of speech begin the series, which leads through signals, lines, transmitters, receivers and other parts of the telephone up to the complete telephone instrument. Party lines occupy three chapters, electrical hazards and protection against them follow, before taking up the telephone central office. The latter is treated first as to general features, then the simple magneto boards, leading by easily followed steps up to the common battery multiple board and the multi-office exchange.

Automatic switching occupies three chapters, a general discussion of Automatics, the Strowger systems and the Panel system. The general discussion brings up many arguments against automatic switching which are now obsolete, but in contrast many of the advantages are fairly stated. The total impression which the reader gathers is that automatic switching is yet on trial. The events of the past few years show that the trial is over and the verdict is being pronounced.

The treatment of the super-service manual switching very fittingly follows after the automatic systems, from which it drew its inspiration. This is, we believe, the first publication of these circuits, and they possess unusual interest to telephone men.

Power plants and central office buildings are well described, followed by private branch exchanges and intercommunicating systems.

AN EXCELLENT START.

On the 24th ult. a meeting of the Electrical Contractors of Ealing was held at 1, Sandringham Parade, Ealing Broadway, when officials from the central office of the Electrical Contractors Association were present, and a sub-branch of the Association was formed, comprising Electrical Contractors in the Ealing area. Mr. A. G. Mead was elected as Chairman; Mr. J. E. Honar as Secretary and Treasurer; the Committee consisting of Messrs. Paul, Honar, Geoffrey and Hutt. Mr. J. D. Knight, M.I.E.E., Chief Electrical Engineer to the Borough of Ealing, was also present, and the proceedings terminated with a very pleasant dinner, provided by the Ealing Contractors, at which the President and other members of the central body were entertained.

* Price 28s. 6d. net, post free to any part of the world, from S. Rentell and Co., Ltd., 36, Maiden Lane, London, W.C. 2.

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Questions and Answers by Practical Men.

RULES.

QUESTIONS: *We invite our readers to send us questions, preferably on technical problems that have arisen in actual practice. Questions which we consider of sufficient interest to our readers will either be replied to under "Answers to Correspondents" or replies will be invited from our readers. One shilling will be paid for the question which we select for competitive replies in this column.*

ANSWERS: *A fee of 10s. will be paid for the answer which we consider shows the greatest merit, and 5s. for the one we select as second best. In judging the replies, importance will be attached to clearness and conciseness, as well as accuracy. The Editor reserves the right to make no award, or to accept only one reply, if, in his opinion, the answers received do not possess sufficient merit. Competitors desiring the return of their manuscripts, if unaccepted, should enclose stamped addressed envelope.*

Write on one side of the paper only, and if diagrams are sent, draw them on a separate sheet of paper attached to the manuscript. Competitors may adopt a "nom de plume," but, both in the case of questions and answers, the competitor's real name and address must be sent with the manuscript as a guarantee of good faith. No correspondence will be entered into with regard to successful replies. The Editor's decision is final.

Commencing with Question No. 101, a Diploma of Merit will be awarded to the six competitors who win the first or second prize the most times during the next twelve months.

The words "Questions and Answers" or "Q" and "A" should be placed at the top left-hand corner of all letters intended for this column.

QUESTION No. 153.

Is the old Marconi coherer suitable for wireless telephony receiving sets? If so, how can I adapt it for this purpose?—"B.B."

QUESTION No. 154.

I have a new accumulator enclosed in a celluloid case. Its capacity is 50 ampere hours. I notice that sulphating has commenced to take place, not on the plates, but on the bars which hold the plates together. Is this injurious? If so, how can I prevent it?

—"PAX."

(Replies to Questions 153 and 154 must be received not later than February 10, 1923.)

Answers to Questions.

QUESTION No. 149

Is it possible to start a three-phase squirrel cage induction motor that has:

(*a*) One phase short-circuited.

(*b*) One phase interrupted.

If either of these faults occur after the machine has been run up to speed, what will be the result?—"B. C."

REPLIES TO QUESTION No. 149.

The first prize (10s.) has been awarded to "D. J. Wilson" for the following reply:—

It is impossible to give a plain Yes or No to (*a*), since everything depends upon the condition of the stator windings after the fault, and also upon the mode of connection.

Now a short circuit in one phase may only cut out a portion of one coil, or it may cut one or more complete poles out of action.

In the one case it would be known as an "internal short in one phase," and in the other as a "short across phases." The reader must not confuse one with the other, since the symptoms are suite different.

It is usual in three-phase winding to employ three slots per pole per phase, and if only a portion of one coil be effected, then the motor will generally start as though in order, for a time, depending entirely upon the gravity of the fault. Sparking may or may not been seen in the windings when switching in, and the starting current may be higher, depending again upon the gravity of the short and also the output of the motor. (In some cases the contact resistance may be as high as the resistance of the part cut out.)

After the motor is up to speed, local heating will be noticed in the neighbourhood of the shorted coil, followed by the smell of burning, and smoke will probably be seen puffing out of the stator. Since there are three coils per pole, the other coils of the same pole will quickly be charred, as also will be the neighbouring poles, which are of other phases.

The motor should, of course, be stopped before this occurs automatically. If the windings test O.K., *i.e.*, high insulation resistance and continuity (strange though it may seem, this is quite possible), and if the air gap is found in order, then the smoke has been caused by a short, and the windings must be examined.

The faulty coil will be easily detected by its charred appearance, and is easiest remedied temporarily by cutting it out altogether. After these temporary repairs it must be understood that the windings are to be overhauled at the earliest convenient date.

Care and discretion must be used when cutting out the coils; care must be taken that the good coils are not damaged. If the connections round and about the damaged coil are mummified they must be stripped of the tape so that they can be traced back with certainty. The lead that was connected to the start of the damaged coil must now be sweated to the start of the next coil, *i.e.*, connect the two open ends left by removing the damaged coil.

The removal of a complete pole necessitates mor care and is not to be entertained, except under expert advice.

If the short is suspected while the motor is in the workshop, low voltage current can be passed round the stator (with the rotor drawn), and a screwdriver slithered around the rotor tunnel. The absence of magnetism at any point will indicate the position of the shorted coil.

Internal shorts may be difficult to detect. The writer remembers a motor which was damaged by lightning, and many shorts were created in the coils themselves (not across the lines). As the shorts were only pinpricks they gave very little evidence externally.

Testing with low voltage current was not reliable in this case, and in order to quickly locate the faulty coils the stator was connected to the line (usual working voltage) with the rotor drawn. The breaker was held in for about 20 seconds or so, when it was noted that the faulty coils were smoking. They were then removed and the windings overhauled.

Had this machine not been tested in such a drastic manner, it is possible that the coils would have been replaced at short intervals, the motor running O.K. for a few days between each repair.

In the event of the short appearing between two neighbouring poles, *i.e.*, between two phases, the fault is much more serious; particularly is this so if the short occurs near to the leads, say, in two of the coils to which the incoming leads are jointed.

It will be seen that under these conditions the motor could not start, since the current in two of the lines would only travel as far as the short.

In this case, when the switch was closed, the motor would "grunt," with a particularly violent vibrating sound, take a very heavy current, and trip the starting switch or blow the fuses, often doing both. Fire may possibly be seen in the windings when closing the switch.

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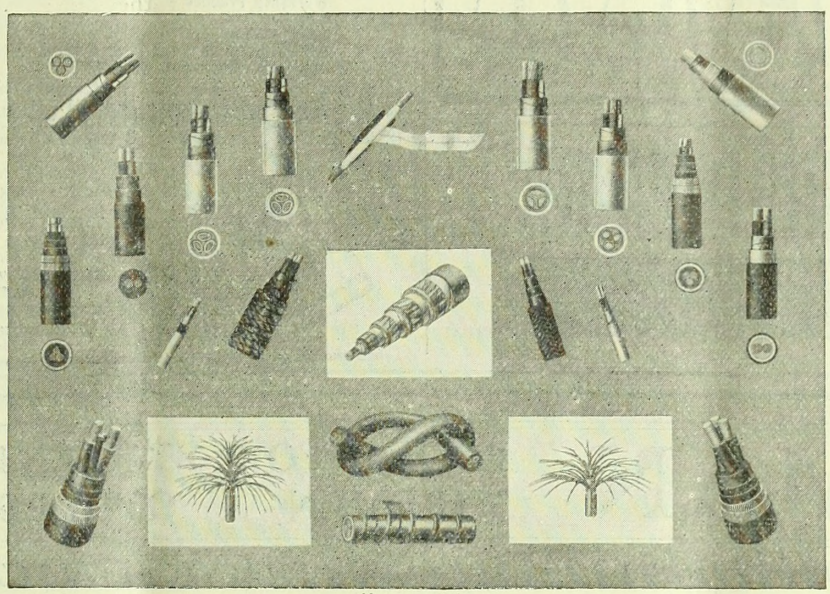
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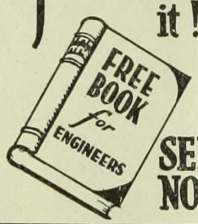
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This fault is easy to detect with the megger if six leads are brought out of the carcass. The six leads are, of course, the starting and finishing ends of the coil belonging to the three phases. Now, if one test wire be fastened to any motor lead, and we get a zero reading at more than one of the remaining leads, we have obviously an internal short. It is usual with some makers to bring three leads only to the terminal block, and in this case the violent metallic vibrating sound is quite sufficient to order the removal of the motor to the repair shop. Here the neutral point can be opened and the phases tested separately, or if more convenient, low voltage current can be used as before.

Should this fault occur while running, the motor would grunt and quickly slow up and stop by blowing the fuses or tripping the switch, or it may "bang" and stop very quickly.

In an exceptional case it would be possible for the short to clear itself and the motor would then start up and run for a short period. This depends upon the gravity of the short, and in general the motor will refuse to start.

Concerning (*b*), No, the motors will not start. Here again the faults are apt to be deceptive; for instance, suppose we get a break in a coil due to an internal short, then the motor would keep running, but if stopped would not start again, unless the broken wires had burned through the cotton covering of its neighbours in the same slot.

If this did happen the motor may run for a short period and be apparently in order. The motor when running on two phases would have a different sing than usual, generally a lower tone, turning at times to a groan.

When testing for these broken coils which have apparently become jointed the megger is not very useful, as it is possible to have a high insulation resistance and also continuity. Unless the tape be charred the easiest method will be to pass low voltage current through each phase winding separately and note the phase taking the highest current. Keeping this phase in circuit will heat up the coils, the faulty one showing up first and keeping hotter than the others. Testing with the screwdriver as previously described may also be helpful.

Another interesting fault which will not be out of place here may occur when two three-phase motors are connected to one set of fuses. If a fuse blows when one motor is running, it will be possible to start up the other and thereby lead the electrician to believe that the fuses are O.K., since, of course, three-phase motors will not start on two phases. In the case of motors of different output, say, 20 h.p. and 50 h.p., then if the 20 h.p. was running, the 50 h.p. would start up sluggishly, and, if heavily loaded, would not accelerate.

The whole of these faults and remedies are, of course, equally applicable to the stators of motors with wound motors.

"D. J. WILSON."

The Second Prize Winner's reply will be published in due course.

Correspondence.

CAN ANYONE EXPLAIN?

[The following is selected from further replies received to the interesting query recently raised in our columns.]

To the Editor of ELECTRICITY.

SIR,—Most people will have noticed at one time or another that the wheels of vehicles seen on the cinema often appear to be skidding violently, or even revolving backwards.

In order to explain clearly the reason for this phenomenon, it is necessary, first of all, briefly to review the principle on which the cinematograph depends. Cinematography owes its existence to that property of the eye which is known as "persistency of vision." Due to this property of the "retina," the effect of a ray of light incident upon it always takes an appreciable time to die away after the actual ray has been cut off, or in other words, the effect "persists." The actual time taken for the "retina" to recover its normal state is somewhere about one-tenth of a second; it is thus impossible to distinguish separate flashes of light at a greater frequency than about 10 per second, since the effect of one flash has not died away before the next succeeds it; and the eye conveys to the brain an impression of a continuous ray of light.

The film consists of a series of snapshots taken at the rate of about 16 per second. Take, for instance, the example of a man walking; in each of these photographs he will, of course, be shown in a slightly different position, no two being exactly alike.

When the film is run through the projector, each photo is shown in turn as a separate flash, and since, owing to the "persistency of vision," these flashes cannot be distinguished by the eye, the effect of motion is produced by the difference between each successive photograph.

It will now be possible to explain the peculiar appearances presented by wheels or other rotating objects.

Let us take, for simplicity, a wheel having only four spokes, as shown in the figures, and suppose that it is rotating in a clockwise direction. Let us consider that a photo is taken of it when the spokes *a*, *b*, *c*, *d* are as shown in Fig. 1. When the next photo

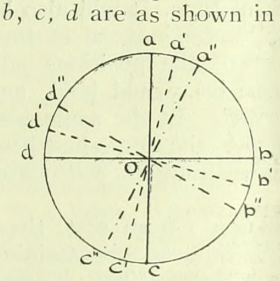


FIG 1

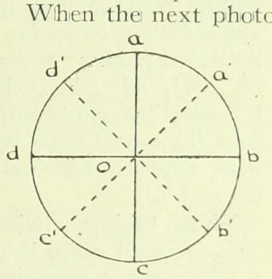


FIG 2

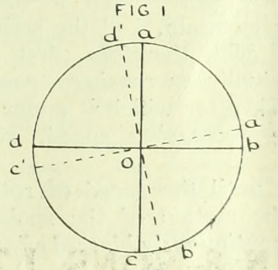


FIG 3

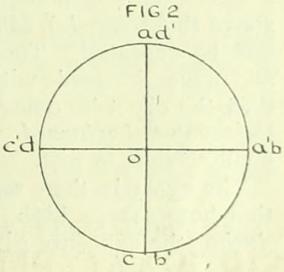


FIG 4

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is taken, the wheel will have rotated through a certain angle, whose magnitude will depend on the speed of rotation. We can imagine now four different cases, *i.e.*, when the wheel has rotated between successive photos through an angle which is:—

(*a*) Less than half the angle between adjacent spokes.

(*b*) Equal to half the angle between adjacent spokes.

(*c*) Greater than half the angle, but less than the whole angle between adjacent spokes.

(*d*) Equal to the whole angle between adjacent spokes.

Case (*a*).—Suppose that the wheel has rotated through an angle aoa^1 so that in the next photo the position of spoke *oa* becomes oa^1; in the third photo its position will be given by oa^{11}, and so on. When this is projected on the screen, the effect will be, naturally, that of *clockwise* rotation.

Case (*b*).—If, however, the wheel is rotating at such a speed that it has moved through half the angle between adjacent spokes, oa^1 will be midway between *a* and *b* (Fig. 2). Now it is equally possible for the eye to assume either that the spoke *oa* has moved *forward* to oa^1, which will give the effect of clockwise rotation, or that the spoke *ob* has jumped *back* to oa^1 (since, owing to the similarity between the spokes, the eye cannot distinguish *oa* from *ob*), and this would give the effect of counter-clockwise rotation. The eye is, as it were, in a dilemma, and may consider the wheel to be moving forward at one instant and backwards at another; and the result is that a confused and blurred effect is produced.

Case (*c*).—In this case the spoke *oa* will have moved to oa^1 (Fig. 3), where aa^1 is greater than a^1b. It would be possible, as in the last case, for the eye to consider that *oa* had moved forward to oa^1, but since a^1b is less than aa^1, it naturally chooses to assume that *ob* has moved *back* to oa^1, and this gives the effect of *counter-clockwise* rotation, or, in the case of a vehicle, of the wheel moving backwards.

Case (*d*).—The last case is that in which *oa* moves to oa^1 (Fig. 4). Since the eye cannot distinguish between respective spokes, no effect of motion is produced, the photos are to all appearance, identical, and the wheel appears at rest.

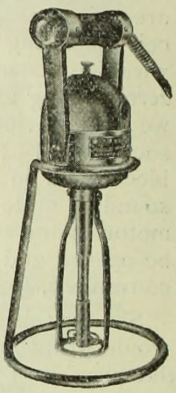
In the most usual case met with, *i.e.*, motor-car wheels, it is unlikely that their speed of rotation will remain constant for any length of time. It will also be noticed that if spoke *oa* had, in the interval of time between photos, moved to any of the positions oa^1 ob^1, oc^1, od^1 (Fig. 1), that case (*a*) would hold, and the rotation would appear *forward*. In the same way case (*b*) would have been ratified if the angle had been 135°, 225° or 315°, instead of 45°. Similarly with cases (*c*) and (*d*).

Thus, taking a wheel speeding up from rest, these cases will all occur in order while the wheel is attaining a speed corresponding to case (*d*). When it rises above this, case (*a*) will come in again, and the series will be repeated. The wheel will, therefore, first of all move *forward* with gradually *increasing* speed, then the effect becomes blurred, after which it appears to revolve *backward* with a *decreasing* speed, and finally comes to rest.

The cycle is then repeated until the speed of rotation becomes so high that the motion of the spokes *during* the exposure gives a *continuously blurred effect*.

A. W. HIRST, B.Sc. (Eng.).

AIR-O-MIX WHIP-ALL.



The food and drink mixer illustrated below is known as the AIR-O-MIX WHIP-ALL, and may be obtained from the Sun Electrical Co., Ltd. (118-120, Charing Cross Road, W.C.2). The general arrangement of the handle, two-speed motor, etc., is clearly seen, and when set in operation the motor quietly and rapidly drives the spindle, at the bottom of which are two aerial tubes. As a result the material being mixed is also aerated, and it is claimed that by its use for mixing the ingredients, cakes, etc., come out very much lighter in cooking, while milk thus aerated is rendered capable of digestion by the most delicate stomach.

Reviews of Books, &c.

[Books noticed in this column will be sent from ELECTRICITY *Office to any part of the world, for the published price, plus ten per cent. for postage (minimum 2d.) and orders will be appreciated.]*

ELECTRICAL HOROLOGY. By Langman and Ball. Cr. 8vo, Cl., 164 pp., 68 illustrations. (Lockwood. 7s. 6d. net.)—There is a continued steady growth in the demand for accurate time-keeping, and also for the simultaneous control of large time systems in stations, factories, etc., where it is essential that all clocks should register alike. The result of this growth is a quiet but steady demand for books on electric time systems, and this new work is a comprehensive history of the subject from its early days, as well as a thoroughly practical and remarkably well-illustrated description of the various leading systems now on the market and in everyday use. Naturally, attention is concentrated more on the electrical or mechanical principles of operation than on the actual clockwork, and the result is a work which should have a wide sale among all electricians and inventors who may be working on time-recording apparatus. The printing is excellent, and it is a pleasure to follow out technical drawings which have been so clearly reproduced.

We have received from the D.O.T. copies of the Government Reports on the Economic and Financial Conditions in Cuba, to September, 1922 (10d., post free); British West Indies, to June, 1922 (1s. 2d., post free); and Argentine Republic, to September, 1922 (1s. 8d., post free), all of which contain information of direct value to British manufacturers and merchants who trade with or may wish to open up business with these countries respectively. Electrical supplies are referred to in all three reports, so that British manufacturers and exporters of electrical plant and accessories should be interested in all three publications.

REPORT OF THE COMMERCIAL, ETC., CONDITIONS IN CHINA IN JULY, 1922. By H. H. Fox. (H.M.S. Office, 2s. net, post free.)—This is another of the useful reports of the Department of Overseas Trade, and will interest a very large number of British electrical firms who

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export goods to the Land of the Great Yellow Dragon. It contains a great deal of practical information, and shows that the Chinese imports of electrical materials and fittings rose from six million taels in 1920 to thirteen million in 1921. Further, a company has just recently purchased land in Soochow on which to erect works for the manufacture of motors and electrical appliances, this being the first project of this nature to be mooted in China. The wise action of the British Government in foregoing the Boxer Indemnity in order that the money may be devoted to the training of Chinese students in English centres of learning in engineering training, should also do much to stimulate British trade.

PITMAN'S RADIO YEAR BOOK. (Pitman; 1s. 6d. net.)—This Year Book is intended as a book of reference to all interested in broadcast receiving, and the present activities of the British Broadcasting Co. will undoubtedly create among all persons possessing wireless receiving sets the necessity for some such small book of reference.

The frontispiece is a map showing the location of the broadcasting stations, four of which are already at work, and the other four will be completed at an early date.

Contributions to the book have been made by many distinguished radio engineers and scientists, and the book opens with an article by Mr. E. A. Shaughnessy, O.B.E., M.I.E.E., M.I.R.E., who explains clearly the reasons for the restrictions which have been imposed on broadcasting. All amateurs and those interested in wireless should read and most carefully observe Mr. Shaughnessy's article. We would go further and suggest that there are many amateurs to-day who would do well if they learnt the article by heart.

The conditions which broadcasting receivers must fulfil to obtain Post Office approval are given, together with other data on the question of authority for experiments in wireless telegraphy. Details relating to the Broadcasting Co. are given, together with schedules of wireless societies in Great Britain, and details of stations of special interest to amateurs. Unfortunately, the book does not give a list of amateur radio stations, which would be of particular interest to all persons possessing a receiving licence of any kind. We should recommend the publishers to include a full and detailed list in their next edition.

A fair amount of space is taken up by the trade directory, and it is questionable whether this information appeals to those who would purchase the book.

On the articles generally, and particularly those in the technical section, one can only express approval, as each article is written by an expert in the particular branch of wireless on which he writes.

The book is to be recomended, as for the small sum of 1s. 6d. it contains much information of technical value and of interest.

It may be as well here to point out to purchasers of the book that on page 52, Fig. 13, the wrong diagram has obviously been inserted, as it shows the connections of an ordinary loose-coupled tuner, and no reaction coil is shown.

THE GOLDEN HAMMER AND OTHER ENGINEERING STORIES. By A. W. Marshall. Cr. 8vo, cl., 188 pp., illustrated. (Percival Marshall, 3s. 6d. net.)—This is a reprint in book form of various stories which originally appeared in the columns of our excellent contemporaries *The Model Engineer* and *Junior Mechanics*, and in them the author has aimed directly at fostering among his many readers habits of industry and perseverance combined with a spirit of sympathy, hope and encouragement. He should most certainly succeed. The nine tales are capitally written and will interest seniors as well as juniors. At any rate, we found them most engrossing, and finished the series with a sigh of regret. We could do with more of the same medicine.

REACTANCE WIRELESS SETS AND BROADCASTING LICENCE.

Messrs. Rogers, Foster and Howell, radio engineers, of Edward Road, Birmingham, announce that they have now perfected two-, three- and four-valve receivers containing reactance, but conforming in every respect with the regulations of the ordinary broadcasting licence. As an example of the advantages possessed by the new reactance set, it is stated that in the maker's testing laboratory, which is situated within three miles of the Birmingham Broadcasting Station, it is possible to "tune out" the latter when it is in full operation, and to receive either London, Manchester, to say nothing of Paris, or The Hague concerts at maximum strength, without loss of volume or distortion. The importance of this will be appreciated by anyone who has hitherto been using an ordinary receiver within a few miles of a high-power broadcasting station, and knows the difficulty there has been in the past in cutting out the local station to concentrate upon another more distant concert.

Trade Notes.

In a new edition of the Simplex Lighting Fixtures Catalogue No. 970 is shown an excellent selection of fittings, which may be taken as typically representative from a comprehensive range which, besides the usual brackets, pendants, semi-indirect fittings, table lamps, etc., includes fixtures on the Simplex Unit system, "Triple-Purpose" signs and several weather-proof lanterns. In connection with this last item, we might mention that a complete and fully illustrated catalogue of industrial lanterns, shades and reflectors is in the hands of the printer, and is expected to become available during the first week of February. Of this present list it should be added that two separate impressions are being issued, the one for home purposes only, and the other for special distribution to overseas buyers, particularly those in the Colonies. The Trade can obtain copies and full information from **Simplex Conduits, Ltd.**, Garrison Lane, Birmingham.

In a recent issue we referred to the revised list of prices which had been issued by **Messrs. Marryat and Scott Co., Ltd.**, of 28, Hatton Garden, London, E.C.1, as a supplement to their complete lift catalogue issued in 1921. The catalogue itself is now in front of us, and can be recommended to architects, engineers and contractors as a valuable adjunct to the bookshelf of any engineer who is likely to have to prepare estimates or place orders for lifts, hoists, winding engines and, generally speaking, the various types of machinery which are necessary in this class of installation work. It is a beautifully illustrated list. The colour reproductions showing the various types of lifts produced by the company are veritable works of art, and our only hope is that there will be such an improvement in the building trade as will permit of a large demand for these goods. In that case Messrs. M. and S. are certain to receive a high percentage of the orders.

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Various Items.

Week-end Wireless Letters.—Marconi's Wireless Telegraph Co. announce that they have introduced a week-end wireless letter service to the United States at the rate of threepence per word without minimum.

Rats Again.—During a recent week the tram service of Belfast was held up by a rat which entered a cable main at the power station. It paid for its amusement by being electrocuted in quick time.

Java.—The British Commercial Agent for the Netherlands has forwarded to the D.O.T., 35, Old Queen Street, S.W.1, a review of the general trade of Djokjakarta. From this it appears that the town is the centre of the sugar industry and that it has been very prosperous indeed. Sugar machinery and electrical goods are in steady demand, and it is to be hoped that British export firms will do their best to increase their share in the trade.

To Telegraphists.—When the editor of the *P.O.E.E. Journal* says of *The Telegraphists' Guide* that it: "Should meet the requirements of a large body of students . . . very useful for telegraphists and others who are studying for the examinations," and the editor of *The Telegraph and Telephone Journal* (the official organ of the G.P.O.) says: ". . . this very faithful 'Guide' . . . the book is lucidity itself. . . No telegraphist aspiring to a technical knowledge of his profession should be without his copy," it may be assumed that it gives accurate and up-to-date information. Just so, and for Grade 1 candidates the book has no equal at the price, viz., 4s., post free, from S. Rentell and Co., Ltd., 36, Maiden Lane, London, W.C.2.

New Institution.—We have received from the Institution of Engineering Inspection, the registered offices of which are at Palace Chambers, London, S.W.1, a notice that a paper will be read by Mr. H. T. F. Rhodes, on "Chemical Inspection as it is and as it Should Be," at the Rooms of the Royal Society of Arts, John Street, Adelphi, London, W.C.2, on Friday, February 16, at 7.30 p.m. Also, a pamphlet descriptive of the objects and aims of the Institution, which was originally founded as the Technical Inspection Association, and aims at the development of skilled inspection, which will, of course, appeal to a very large number of electrical engineers, who have to undertake work of this description. Full particulars may be obtained from the Secretary on application.

Meetings.—The Inst. of Production Engineers will meet at 7.30 p.m. on Friday, 2nd inst., at the Engineers' Club, Coventry Street, W. 1. Paper:—"The Moving Picture in Industry," with pictures, by Mr. G. E. Turner. All interested are invited to attend, whether members of the Institution or not, and no tickets are necessary.——The Society of Engineers will meet in the apartments of the Geological Society, Burlington House, W., on Monday, 5th inst., at 5.30 p.m. Paper:—"Practical Notes on Inspection," by A. Collis-Brown, A.M.S.E.——The Junior Inst. of Engineers will meet at 39, Victoria Street, S.W. 1, on Friday, 2nd inst. Lecturette, "Ventilation and Lighting of Factories" (slides), by P. J. Waldram. Also on Friday, 9th inst., Hon. Members' Lecture, "The Effect of Temperature on the Properties of Engineering Materials," by Prof. F. C. Lea, D.Sc. (slides). And on Friday, 16th inst., Lecturette, "Notes on Some Insulating Materials," by T. L. Allison. All at 7.30 p.m. On Saturday, 17th inst., at 2 o'clock, there will be a visit to buildings in course of construction at Wembley for the British Empire Exhibition.

Bolton.—The County Court, on January 11, was called upon to decide the novel point as to whether it is possible for anyone on a tramcar to sustain an electric shock. The case was one in which Jonathan Booth, tram driver, sue dfor damages. His case was that he was teaching a probationer driver when the car refused to move, though the full 500 volts were applied. Plaintiff gripped the canopy standard and found it alive, the result being that he received a shock. He could not remove his hand until the other man had shut off the power. The defence was that it was impossible for anyone on the car (even if the car were "alive") to sustain an electric shock, because of the fact that the car was insulated. Thus anyone travelling on it was insulated too. A medical specialist said he would never have dreamt, on examining the man's hand, that he had had an electric shock. The Judge said the case was both "sad and interesting." He was bound to accept the evidence for the Corporation that a person could not sustain a shock in the manner alleged. There must have been a sudden stoppage in one of the man's minor arteries. He found for the Corporation with costs.

Bulgaria.—Batteries and telephonic materials are required by the Posts and Telegraph Dept. Specification (in French), together with explanatory blue prints, can be inspected at the D.O.T. (Room 49), 35, Old Queen St., London, S.W. 1.

Electric Furnaces.—On the 7th inst. a paper entitled "Electrical Resistance Furnaces and their Uses" will be read before the Royal Society of Arts by Mr. Chas. R. Darling. Time, 8 p.m. Sir Robert Hadfield, Bart., in the chair.

I.E.E. Annual Dinner.—We wish to remind our readers that this function will take place on Tuesday next (February 6). Those intending to be present and who have not already applied for tickets should do so without delay, as otherwise they will run the risk of finding that the whole of the seating accommodation has been allotted.

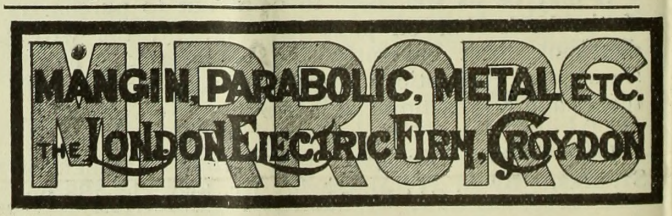
The "Hart" Blotter.—As usual, we have to thank the Hart Accumulator Co., Ltd., of Stratford, for a useful blotting pad for the year 1923. These annual reminders are always much appreciated by the recipients, and undoubtedly help to keep the Hart accumulators well before the notice of their clients in all parts of the world.

Stranorlar (Co. Donegal).—The work of erecting the standards, etc., in connection with the electric lighting of this town is approaching completion. When the public lighting has been effected, that of private lighting will be taken. Encouraged by the Stranorlar scheme, the neighbouring town of Ballybofey is taking up a scheme, which it is hoped will be carried out to a successful issue.

Freemasonry.—Particular interest attached to the regular meeting of the Kelvin Lodge, which was held at Mark Masons' Hall on Friday, the 26th ult., owing to the fact that the clothing of "London Rank" was presented by the W.M. and brethren of the Lodge to W. Bro. Osborne Pearston, Past Master. Mr Pearston is a well-known member of the staff of the *Electrical Review*, and as such has many friends all over the kingdom, who will doubtless be interested and pleased to hear of this Masonic dignity which has just been conferred upon him.

"Light-o'-Day" Daylight Lamp.—By means of what is apparently an etching solution, any make of vacuum or gas-filled electric lamp with clear globe can be converted at small cost into a lamp giving a very close approximation to daylight (about the benefits of which for comfort or colour matching there is no need here to dilate). Particulars and prices can be obtained from the British concessionnaires, Messrs. Gordon and Barclay, 20, Copthall Avenue, London Wall, E.C. 2. The process, known as the Oriona process, has only been available here for a few weeks, but already has been taken up by a number of important trading concerns, including Selfridges. Lamp factors, contractors and users will all doubtless be interested in this development. The absorption of light is, we are advised, only some 10 to 15 per cent.

Australian Items.—According to our contemporary, *The Industrial Australian*, of December last, the report of the Victoria Electricity Commission for the year ending June 30, 1922, shows that the amount expended during the year was £1,500,000.——Particulars are given in the same issue of the Melbourne Metropolitan Tramways extension. The Tramways Board has prepared some very comprehensive plans covering about 141 miles of new lines, which will ultimately allow for the service of equivalent to a population of over 1,000,000, and it is estimated that when completed they will carry 411,000,000 passengers per annum. Full details are given of the proposed new lines, together with a map showing the districts which will be served. This is an important project and should represent a very large amount of work for English traction engineers.——It is proposed to harness the Buffalo River in order to provide cheaper hydro-electric energy for the Mount Buffalo Chalet and the residents of the Ovens Valley. It is expected that the matter will be referred to the Commission by the Ministry, after which steps will be taken to detail a survey party to make the necessary investigations. ——A new plant for light and power is to be put down at Swan Hill on the Murray in Victoria. This is necessitated by the demand for additional current. Fairbanks-Morse plant is to be installed, and this will represent a change over from suction gas to oil engines.



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A POPULAR SCIENTIFIC WEEKLY JOURNAL
ELECTRICITY
A PRACTICAL TRADE JOURNAL

FEBRUARY 9, 1923.

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CO-OPERATION BETWEEN ARCHITECT AND ILLUMINATING ENGINEER.

A Worthy Result.

Although when designing new buildings architects pay a great deal of attention to the problem of daylight lighting, it is unfortunately somewhat rare for the equally or more important question of artificial lighting to be dealt with as an integral part of the building.

A recent example of a lighting scheme planned in conjunction with the design of the building and representing a breakaway from conventional methods is to be found in Messrs. Austin Reed's new premises in Leeds. Some particulars of the way in which the problem has been tackled should, therefore, prove of interest and importance. In the first place, the main showrooms on the ground and first floors are lighted

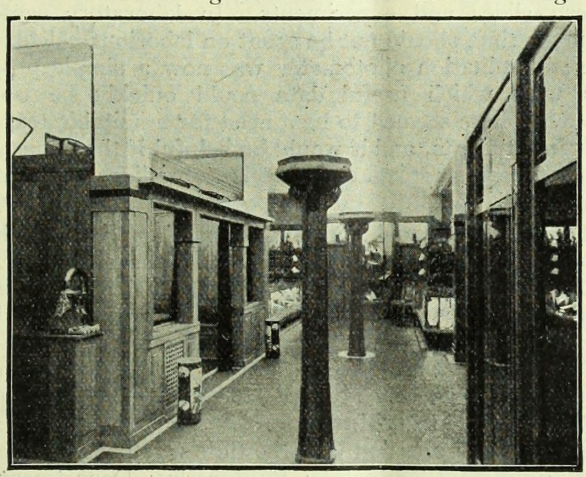


Fig. 1.

on the indirect system, the reflectors being concealed in the tops of ornamental wood pedestals about 7 ft. 6 in. high, standing in the middle of the floor. Fig. 1 illustrates one of the showrooms. The main illumination is provided by two pedestals, each fitted with three X-ray reflectors and three Mazda gasfilled lamps. The pedestals were designed by the architects to harmonise with the panelling and other woodwork. These main units are supplemented by X-ray reflectors concealed in the tops of shelves and similar fixtures.

The illumination is well diffused throughout the showroom, and from the decorative and architectural point of view the advantage of keeping the ceiling clear of suspended fittings in a room of this kind is obvious.

In the ready-made clothing department, Fig. 2, the light sources are not merely invisible but are external to the room. This department is on the top floor and has a frosted glass roof which provides natural lighting

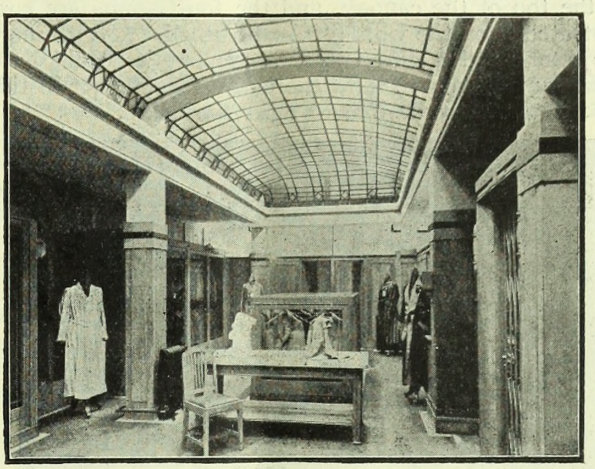


Fig. 2.

during the day. Above this glass roof are fixed a number of X-ray reflectors containing high-powered Mazda gasfilled lamps, and the light from the lamps is reflected downward through the glass.

The interior, shown in Fig. 3, is lighted by pedestal and "fixture-top" units as in Fig. 1, but only a portion of one of the pedestals is visible.

An interesting feature is the lighting of the showcases seen on the right. X-ray "Scoopette" reflector units containing Mazda Navy Bulb lamps, fixed along

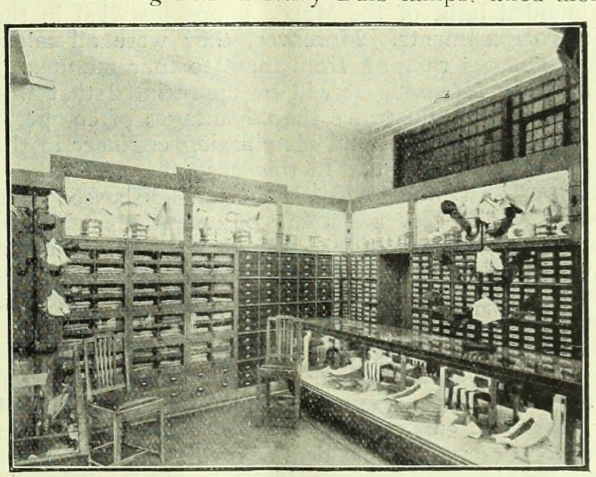


Fig. 3.

the top front edge of the showcase, being used. The light is thrown down and back on to the display, and the lamps are concealed by the opaque reflectors. This system of lighting is entirely successful, and the localised brilliance—as of a miniature theatre stage—

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lends enchantment to the display which will lure money out of many a tightly-buttoned pocket.

The windows are lighted in the same way as the showcases, but with larger reflectors and lamps. The X-ray units are fixed along the top front edge of the window and are concealed by a narrow curtain.

Fig. 4 illustrates very effectively the brilliant stage-like illumination of the window. For permission to reproduce it, as well as the other three illustrations, we are indebted to the proprietors of the *Architect*. The same picture also shows how the name at the top of the building is lighted. Four B.T.-H. Floodlight Projectors equipped with Mazda gasfilled lamps are fixed to the top of the canopy, and the four beams are concentrated upon the words "Austin Reed." With more projectors and a different arrangement it would have been equally easy to light the entire façade, but in this case it was only desired to light the name.

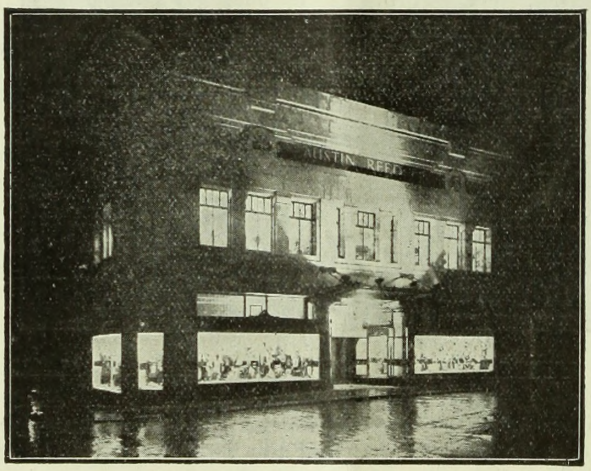


Fig. 4.

The projectors are weatherproof and universally adjustable, and are equipped with powerful reflectors. Practically they are miniature naval searchlights adapted to the pacific needs of commercial illumination.

All the photographs here reproduced were taken by the unaided light of the Mazda lamps installed in the various departments. Moreover, they were all taken with exposures ranging from three to four minutes.

From the foregoing it will be appreciated that this installation well illustrates the advantages of co-operation between architect and illuminating engineer in the early stages of design. In this case the architects—Messrs. Westwood and Emberton—discussed the question at the very beginning of operations with the illumination engineer of The British Thomson-Houston Co., Ltd., of 77, Upper Thames Street, London, E.C.4, and City Square, Leeds. Between them they decided upon the scheme just outlined, which is a most satisfactory one to all concerned. The lamps, reflectors and other lighting equipment were supplied by the B.T.-H. Co., who designed and manufactured most of the material employed. Messrs. Westwood and Emberton deserve a great deal of credit for their enterprise and ingenuity in applying and adapting this material to the special requirements of the new building and for their own very excellent ideas on the subject of artificial lighting.

For Sale.—An advertiser has for sale two new petrol-paraffin generating sets. For full particulars see a small advertisement.

THE NEED FOR SUITABLE TRAINING IN ILLUMINATING ENGINEERING.

At the last meeting of the Illuminating Engineering Society on January 16, a paper on the above subject was read by Mr. C. E. Greenslade and Mr. J. E. S. White. The authors, in the introductory part of the paper, referred to the inaugural address of Professor Silvanus P. Thompson before the Society in 1909, when he had given an admirable exposition of its educational aims. Nowadays everyone is interested in illumination, so that education should embrace all sections of the community. Discussion before joint meetings with other bodies had proved valuable. It would also be useful if occasional lectures before bodies concerned with special aspects of lighting could be arranged. Apart from this it should be possible to arrange interesting popular lectures for the general public.

At the commencement of the educational ladder illumination should also receive attention. The experience of the "Safety First" movement had shown how valuable results accrued from judicious propaganda in schools, and it would have a great influence on the future of illumination if simple lectures could be given to children, so that they grew up with an appreciation of the advantages of good lighting in their own homes, and in the occupations they afterwards pursued.

The authors subsequently discussed in some completeness the arrangement of courses dealing with illumination in technical colleges and polytechnics. There were two possibilities. One might arrange special courses of lectures, at which both students and outsiders could be present; or one might ensure that illumination was adequately treated in the courses attached to electrical engineering and other departments. In some cases the syllabus needed to be brought more up to date, and attention should be devoted to practical applications of light, rather than to lamp manufacture, with which few students would be afterwards concerned. Every effort should be made to make the lectures attractive by good lantern slides and experiments. In laboratory work too much time should not be spent on laborious calculations; illumination photometry was now a simple process with which useful data could quickly be obtained. There seemed to be a need for a suitable text-book for students, and it would be helpful if the Society could prepare a typical series of lantern slides for loan to teachers.

The paper was concluded by a series of queries, which formed the basis of an interesting discussion. Dr. F. T. Chapman, of the Board of Education, gave a sympathetic reception to the suggestions made, and agreed that illumination needed to be treated more adequately than at present. Others associated with technical colleges also favoured the idea of modifying existing courses to deal more effectively with lighting; there was an impression that the time was not yet ripe for a complete Illuminating Engineering Department at colleges, though post-graduate courses might be arranged. Miss Squire, who is associated with the Factory Department at the Home Office, made a very useful contribution to the discussion, pointing out the great need for instruction in illumination amongst managers of factories and workers in connection with

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industrial lighting. Mr. L. Gaster recalled that in 1912 useful sets of lectures had been arranged, with the co-operation of the L.C.C., at a number of technical institutions in London. More elaborate courses had been devised at various colleges in the United States, under the supervision of the Illuminating Engineering Society in that country. He also mentioned that the society had addressed a series of queries to a number of colleges prior to the meeting, and the offer of co-operation on the part of the society had been sympathetically received. The matter would be followed up and it was proposed to appoint a joint committee to deal with details.

In conclusion it was announced that the next meeting would be held on February 20, when a paper on "The Projection of Light" would be read by Mr. W. J. Jones and Mr. E. A. Marx, jr.

A NEW INDUCTION FURNACE.

The simplest form of induction furnace, as shown in Fig. 1, reproduced from the *General Electric Review*, consists of an annular channel-shaped crucible holding the charge of metal, the charge itself forming the secondary of a static transformer. A primary winding, shown diagrammatically in section over the horizontal ring crucible in Fig. 1, interlinks magnetically with a laminated iron core which embraces the secondary as shown. When alternating current is passed through the primary winding, a heavy current is induced in the metal in the crucible, and the heat developed by this current

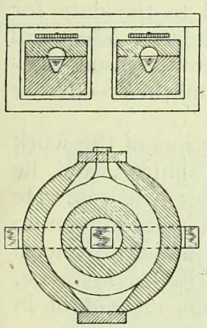


FIG. 1.

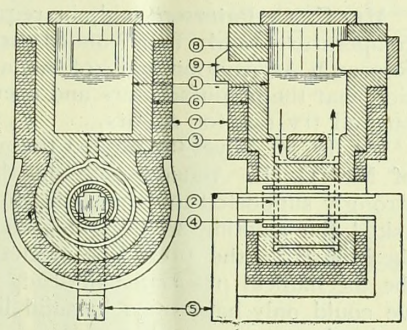


FIG. 2.

melts the charge. In theory nothing could be simpler or more effective, the heat being developed in the body of the charge itself. Unfortunately, the high leakage reactance of the transformer and the low resistance of the single-turn secondary result in very low power factor and make it difficult to get a large amount of power into the furnace. The difficulty is greater the higher the conductivity of the metal which it is desired to melt, and it is impossible satisfactorily to melt brass or copper in the ordinary induction furnace because the magnetic field surrounding the secondary becomes so powerful that it periodically breaks the continuity of the molten metal in the furnace channel.

These difficulties and disadvantages are, it is claimed, eliminated by the new furnace shown diagrammatically in Fig. 2. From this diagram, which shows two vertical sections in planes at right angles, it will be seen that the main body of the charge is in a pot (1) below which is the cylindrical annular chamber (2), wherein heat is developed by induction as in the earlier type of furnace. The primary winding is shown at (4) and the laminated iron core at (5). The refractory lining (6) is surrounded by heat-lagging material (7). The charging door (8) is opposite the pouring spout (9), and the whole furnace represents a sound engineering construction which, as shown below, has important advantages in point of efficient operation.

Electrically the secondary circuit is completed in the channel (2) without entering the main body of the charge, but the hot metal in (2) is made to circulate into the main charge (which it heats by conduction) by electro-magnetic action. It will be seen that the primary winding (4) is displaced axially with regard to the secondary (2), hence the electro-magnetic repulsion between the primary and secondary (which exists in all transformers) is greater at one end than at the other, in the right hand diagram, Fig. 2. As a consequnce the molten metal in (2) is driven up one of the ducts (3) into the melting pot, and cooler metal is drawn down the other duct (3) at the other end of the pot, as shown by the arrows. The flange-like enlargements at each end of (2) help to distribute and collect the metal at the ends of the melting chamber. Through the melting chamber itself the flow is axial, and the rate of circulation can be instantly increased or decreased by varying the axial position of the primary winding.

Interruption of the molten metal in the secondary is impossible in this furnace because there is a good head of metal above the chamber (2); also, the passages of the latter are submerged, hence atmospheric pressure also acts to keep the metal continuous (if the metal were interrupted there would be a vacuum in the space formed). The automatic circulation of the metal maintains nearly uniform temperature throughout the bath, and the application of heat from the bottom promotes rapid melting. Though the point is not mentioned in the description before us, it is presumably desirable to operate the furnace continuously and to leave in the furnace, when pouring, sufficient metal to fill the chamber (2) and cover the ducts (3). The primary winding is obviously not exposed to the risks, thermal and mechanical, which it experiences in the earlier type of furnace, and the relatively small leakage in the transformer system as now arranged conduces to high power factor.

Copper and other high conductivity metals can be melted without difficulty in the new furnace, thanks to the impossibility of interrupting the molten metal. It is claimed that the power factor, even with such metals, approximates to that of an induction motor. In conclusion, it may be noted that the linings for the new furnace can be "ready made," and are thus more durable, cheaper, and more rapidly renewed than the rammed lining required by the ordinary induction furnace.

"**Modern Wireless.**"—Congratulations to our friends, the Radio Press, Ltd., of Devereux Court, on No. 1 of this splendid new journal. It is published at 1s. monthly, and the issue before us is full of interesting matter from cover to cover. There are all sorts of articles in it on wireless subjects, both theoretical and practical, and they include contributions from such leading authorities as Sir Oliver Lodge, F.R.S., Mr. E. H. Shaughnessy, O.B.E., Mr. P. R. Coursey, Lieut.-Colonel Crawley, etc. It will appeal to all readers who have taken up "wireless."

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Correspondence.

CAN ANYONE EXPLAIN?

To the Editor of ELECTRICITY.

SIR,—In reference to the inquiry by your correspondent "Cine-Car" as to the reason why the wheels of vehicles appear to rotate backwards when seen on the cinema screen, the effect is psychological on the part of the observer, and may be thus explained. Imagine a clock face with the spokes of a wheel, one pointing to each hour. Remember that the film picture is composed of a series of successive images.

Assume that the next image to that at which a spoke points to each hour figure occurs when each spoke has advanced clockwise one-quarter of the space between successive hours, and similarly for each succeeding image. The psychological effect will be of the spoke moving clockwise.

But if the spoke had advanced clockwise by the time of the next image three-quarters of the space between successive hours, each spoke will have the appearance of having moved a quarter of the space *counter-clockwise*. This will occur for succeeding images, and the spoke rotation will, as a whole, appear to be counter-clockwise.

The mind, in fact, interprets the movement as having taken place in that direction which gives the smallest interval from the last position.

LLEWELYN B. ATKINSON.

BREAKDOWNS IN PUBLIC ELECTRICITY SUPPLY.

To the Editor of ELECTRICITY.

SIR,—I am very interested in the record of breakdowns in public electricity supply recorded in "Current Topics" of the 2nd inst.

With regard to the recent breakdown at Barrow, this was not due, as inferred in your notes, to a mouse having access to an E.H.T. switchbox on the E.H.T. distribution network. The rodent obtained access to the E.H.T. machine panel controlling a 1,000 kw. rotary converter at the generating station, and as there was only one 3,000 kw. turbo generator running on load at the time the resulting short circuit across the machine bars caused a total shut down of supply.

Every precaution had been taken with regard to the sealing up of cable ducts to prevent the access of vermin to this chamber, and the only possible way in which the mouse could have entered the switch chamber was through a slot in a concrete slab through which passed the switch connecting rod to the low tension control switchboard in the room overhead.

It would appear, therefore, that the trouble was due to faulty design of the switchgear, and the only way to prevent it would have been to provide a sliding cover plate to cover the slot in the dividing slab.

It is interesting to note that the connecting switch rod passes through the slot at an angle and has a slight radial movement. The only way, therefore, to overcome the difficulty is the one I have already indicated, and this precaution has been taken to prevent similar accidents in future.

The remarkable part about the accident is the extremely limited space through which the mouse obtained access to the chamber, and it points to the necessity of designing the E.H.T. switchgear in such a way that all vents and apertures are guarded either by sliding cover plates or similar means to prevent access of vermin.

I feel sure that the above information will be of interest to your readers and will act as a warning to others to take preventative measures against similar accidents occurring in the future.

Yours faithfully,

J. F. HESLOP,
Distribution Engineer.

Electricity Works, Barrow-in-Furness.
February 2, 1923.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

At the informal meeting of the I.E.E. on Monday, January 22, Mr. A. B. Eason was in the chair, when Mr. A. G. Warren opened a discussion on "Insulators and Insulating Materials."

Mr. Warren's remarks were mainly concerned with materials in their relation to the stresses E.H.T. and the new radio frequencies. He stated that, except for a few recorded American opinions, there was very little written matter on the subject, and one had consequently to grope and experiment for oneself, while the problem was complicated by the small units involved.

After describing verbally and with diagrams the operations of electrical leakage, he asserted the needs of the ideal dielectric, and appealed for research into its production.

Mr. C. C. Paterson said, in regard to the data for temperature and time under test, the Electrical Research Association had got out a tentative specification that the manufacturers and users might co-operate on and try out for results.

Mr. H. M. Sayers reminded the meeting of the work of Mr. G. L. Addenbrooke on the subject, and he strongly supported the appeal for further research. He asked the meeting to imagine the enormous boon to the industry if there could be produced a dielectric with the mechanical properties of lead, or if, for instance, we could only have mica in solid lumps instead of in laminations.

Mr. P. Dunsheath boldly assailed the stress hypothesis, using the analogy of the football crowd surging out of a gate, the greatest compression being at the base of the scrum. He thought the whole point was concerned with the generation of heat, and its dissipation.

Messrs. A. C. Collins, W. S. Flight, A. Monkhouse, E. W. Moss, Dr. E. H. Rayner, W. E. Rogers, A. Rosen, and A. C. Warren also spoke.

Mr. Eason reminded the meeting of the smoking concert of the Informal Section to be held at the Engineers' Club on Monday, February 26.

"**Electrical Circuits and Connections.**"—This book by W. R. Bowker is a comprehensive treatise on direct, alternating, polyphase and hydro-electrical engineering circuits, and as such it will appeal to a large number of readers who are directly interested in the heavier branches of electrical installation work It contains a wealth of diagrams and has only just been published. The price is 15s. 6d. net, post free, from ELECTRICITY Office.

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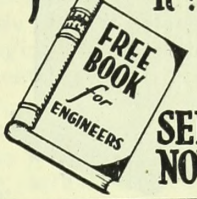
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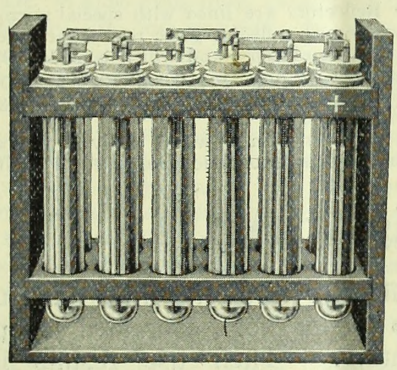
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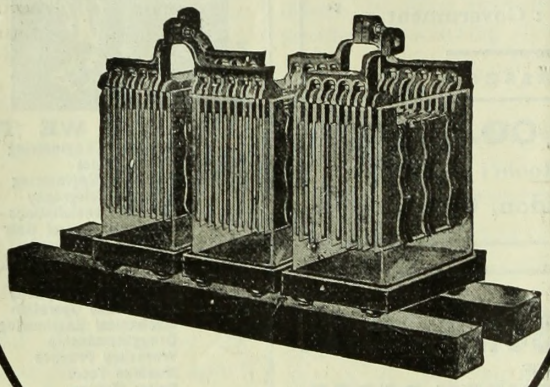
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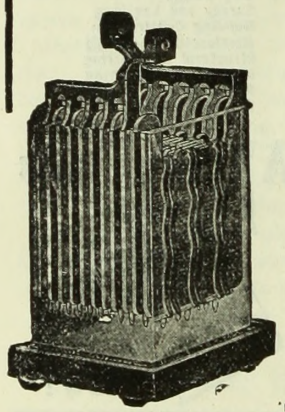
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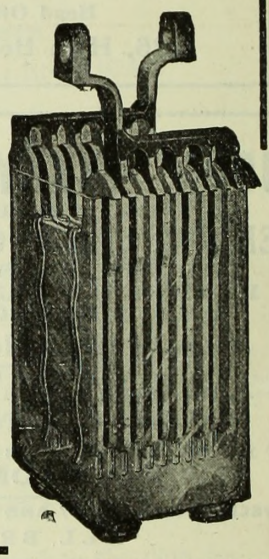
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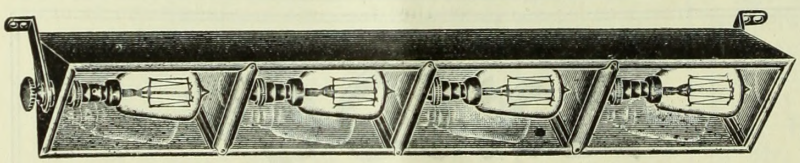


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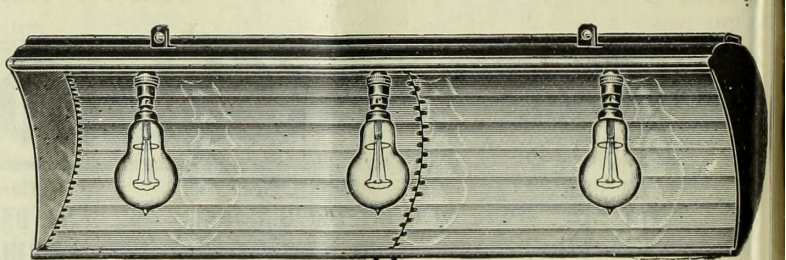
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TO OUR READERS.

ELECTRICITY is published every Friday, and, if ordered, is on sale at the principal Railway Station Bookstalls and Newsagents on that day. It has a very large sale throughout the United Kingdom, as well as in the British Colonies and Abroad.

Questions to which an answer is required must be accompanied by a 1½d. stamp for reply. When considered of sufficient interest, the answer will probably appear in the paper.

New advertisements for the displayed columns and alterations to existing ones must reach the publishing office not later than first post Tuesday morning, in order to be in time for the issue of the following Friday. This is important. Rate quoted on application. Subscription: 13s. a year, 6s. 6d. half year, 3s. 3d. a quarter in advance, postage prepaid in the United Kingdom and abroad.

All remittances payable to the Publishers, S. RENTELL AND CO., LTD., 36 39, Maiden Lane, London, W.C.2. Telephone No. 2460 Gerrard.

Current Topics.

The Gas Peril.

Reverting to the subject of some eidtorial notes of mine a fortnight since, the danger to life and health caused by the presence of an excessive percentage of poisonous carbon monoxide in admixture with the coal gas supplied to the public for lighting, heating and cooking still continues, and almost daily fatalities are reported, directly attributable to this condition. In the circumstances, the apparent apathy of the gas supply interests is the more extraordinary. Coroners generally, in the districts affected, have been most outspoken on the subject, and deserve every credit for their well-intentioned efforts on behalf of the public. The City of London Coroner, Dr. F. J. Waldo, J.P., formerly a Medical Officer of Health, and with 21 years' experience of sudden deaths from various causes, commented very strongly on the carbon monoxide danger in an address to the jury at a recent inquest on the bodies of two men who fell victims to this gas

As Dr. Waldo explained, poisoning by coal gas was due chiefly, if not entirely, to the deadly carbon monoxide naturally contained in it, supplemented by an addition of this gas to the "straight" gas, which itself contained a variable amount—from 4 to 8 per cent.—before the admixture. For reasons of economy the total percentage has been raised, during the past twenty years or more, to 15 per cent. and over of carbon monoxide content, a far more dangerous mixture than formerly. One-half per cent. of carbon monoxide would cause death, and even one-tenth per cent. was injurious. Furthermore, it was a cumulative, insidious, chronic, slow poison. Coal gas is ordinarily recognisable by its peculiar odour, due to the presence of traces of sulphide of carbon. Experiment, however, had shown that coal gas, after slowly percolating through some six or seven feet of earth might become almost odourless, while at the same time gaining an increased percentage of carbon monoxide, and becoming in consequence the more deadly. This probably accounts for those deaths from gas poisoning where gas was not actually laid on to the house, and indicates the further risks attendant upon leakages due to fractured mains laid under streets subject to very heavy traffic.

The City of London Coroner is particularly qualified to speak with authority on this subject, having himself nearly fallen a victim to gas poisoning at the Southwark Coroner's Court some four years ago. At that time the Court was heated by four flueless gas stoves, or radiators, and, experiencing ill-effects after occupying the Court with these radiators in service, Dr. Waldo ordered a full chemical examination of the atmosphere, the result being that carbon monoxide was found to be present in considerable quantity, together wtih fumes of carbonic acid, sulphur, and abundant injurious watery vapour. As an outcome the gas stoves were immediately removed and replaced by three electric radiators, since which time no evil results have been recorded. The moral of this should not be lost upon our friends of the gas world, and it is full time they set their house in order. Meanwhile the obvious and safest course to adopt wherever there is any doubt as to the healthy character of the local gas supply, is to take the earliest opportunity to substitute electricity for lighting, heating, cooking, and even power if need be. Not only is one's health safeguarded, but there are the additional advantages of convenience, cleanliness, labour-saving, greater certainty in cooking, and absence of smoke or soot.

(IM)—Propaganda.

Well-considered propaganda aimed at advertising or popularising a service or product is always to be commended, and the E.D.A. is well to the fore in preaching the gospel of electricity supply service itself, as well as encouraging others to assist in the good work. There has recently appeared in certain organs of the Press, however, what purports to be a disinterested panegyric on electricity; but which is really a veiled allusion to a certain wiring system. To tickle the popular palate, the article is entitled Electrical Flames of Passion, and proceeds to set out in typical journalese the dangers of short circuits in electrical wiring. We all know and recognise the risks of electricity supply, and they are most ably provided for in the excellent Rules and Regulations controlling the supply of electricity to any household or premises. These rules provide for an ample margin of safety, and are to all practical intents and purposes fool-proof; to apply ill-considered propaganda of the character above referred to with the object of exploiting a special wiring system, however meritorious in itself, is the more to be deprecated.

Alas and Alack.

It is with sincere regret that I learn of the eleventh hour breakdown in the negotiations for amalgamation of the Industrial League and Council and the National Alliance of Employers and Employed. Both bodies have most interests in common, and a great deal might have been accomplished by such an amalgamation of membership and unity of effort. Negotiations, begun in October, found representative members of both bodies favourable to amalgamation, and a Joint Committee was appointed, and met to consider the proposal in detail in November. As a result, seven resolutions were passed recommending consummation of the proposed alliance, and a letter embodying these was addressed to the General Secretaries of the two bodies. Subsequently the findings of the Joint Committee were adopted at a general meeting of the Industrial League and Council. At a subsequent meeting of the Joint Committee in January, however, a split occurred over the proposed constitution of the Joint General Council and Executive Committee, and thus we have two excel-

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lent organisations, with common interests and aims, working independently, and consequently inefficiently, each along lines of its own, a fact which is to be deplored.

Behind the Times.

A correspondent in a Liverpool paper draws attention to a curious retention of the old-fashioned lamplighter system in connection with modern electric street lamps in one of the new Corporation suburbs. It seems that although the Corporation have somewhat grudgingly substituted electricity for gas in the lighting of the streets intersecting this new area, they have salved the municipal conscience by adopting individual switches at each standard, which have to be turned on and off by a man going the rounds in the old-fashioned way at the hours of darkness and dawn respectively. This is the more extraordinary, in that the Corporation have emulated the advantages of electricity for public lighting in regard to remote control of large numbers of lamps in connection with their street gas lamps, which are now extensively equipped with clockwork gas-cocks and by-passes, thus dispensing with the services of a gas-lighter. Was it Nemesis or coincidence that a Corporation electric tram-car very nearly demolished the mayoral coach the other day, especially in view of the fact that it was occupied by his lordship at the time, and that he is moreover a prominent member of the Electricity Committee?

Training in Illuminating Engineering.

The discussion on this subject before the Illuminating Engineering Society on January 16 recalls the admirable work of its first President, Prof. S. P. Thompson, in conveying scientific truths to the general public. How aptly he would have dealt with the subject under discussion, and how useful his influence would have proved in bringing the need for instruction in the correct principles of lighting before educational authorities! Mr. Greenslade and Mr. White, who read the opening papers, referred to Professor Thompson's views, expressed in his inaugural address before the society in 1909. Since that date the society has carried many of his conceptions into practice, and it was recalled that in 1912 several courses on illumination were arranged at technical institutes in London.

The present moment is an opportune one to raise the question again. At some institutions lighting is dealt with in existing courses, but the subject-matter requires to be brought up to date. In others there is room for special sets of lectures. In either case the guidance of the society should prove helpful. There is now available incomparably more information on illumination than when the society was started, and there are also a number of suitable lecturers available.

I was particularly struck by the suggestion that some simple hints on lighting might be given to children in schools. In this, as in other directions, we must look to the next generation to carry on the good work. It would mean a great deal to the future of lighting if children could grow up with an appreciation of the benefits of good illumination, equal in importance to such matters as cleanliness and hygiene. Occasional lectures to teachers in elementary schools would enable them to bring the matter before the children, and this seems a judicious way of dealing with the matter.

Vested Interests and Broadcasting.

Now that listening-in by wireless has caught the public taste, and threatens to become increasingly popular, both the theatres and the old-established Electrophone service are feeling a draught, and wondering how the ability to sit at home by the fireside and listen to their singers and comedians is going to affect box-office receipts. Personally, I don't think the advent and growth of broadcasting will make a ha'porth of difference to either of these interests. There is a vast difference between hearing vocal and sentimental music at second hand and by artificial means to hearing it at first hand, and concurrently witnessing the facial expressions and gesticulations of the artistes. It is not even comparable with the cinema, where one sees a play without hearing the actual voices of the actors and actresses. Neither is the real thing, and, despite broadcasting, which nevertheless has a tremendous vogue, theatrical managers will still have their "public" who are not content with less than actual attendance at the seat of production. In any event, the available theatre accommodation to-day in London, and most large provincial cities and towns, is wholly insufficient to afford the would-be theatre-goers that comfort without which a play is not really enjoyable, and broadcasting affords a convenient outlet or overflow meeting facility for the disappointed majority, who will not queue up and risk pneumonia for even the most popular play of the moment.

ELEKTRON.

THE REVIVAL IN TRADE.

There is now every indication that the great "slump" in trade is a thing of the past, and only hard work on efficient lines is necessary to bring the country's trade back to prosperity. The present is an opportune time, therefore, for the publication of such a complete guide to business as *Business Building*, from a perusal of Part I., appears to be. The publishers are Pitmans, and the work is to be completed in 26 fortnightly parts at 1s. each. Intended in particular for the "small man," be he manufacturer, wholesaler, or retailer, it is in no respect dry and technical, but a really interesting and practical treatment of the trader's peculiar problems and difficulties, showing how they may be mastered, avoiding mere theorising, but plainly setting forth directions for the practice of the most modern methods as they are followed in every conspicuously successful business. Part I. contains, besides a valuable introductory section, contributions by Dr. R. W. Holland, O.B.E., M.A., M.Sc., on Business Premises; J. S. Dow on The Lighting of Shops, Offices, Warehouses and Factories; and John D. Troup, M.I.Mech.E., on Industrial Heating and Ventilation. The sections are well-written and fully illustrated, and the publication is really a necessity to the small trader who has a desire to place his business in the front rank.

The Motor Shipbuilding Trade.—According to the current issue of *The Motor Ship*, during the last month orders for eight large motor vessels were placed, and five of these are to be built in British yards. One British firm alone has motor ships, built or on order, totalling 100,000 tons deadweight.

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Questions and Answers by Practical Men.

RULES.

QUESTIONS: *We invite our readers to send us questions, preferably on technical problems that have arisen in actual practice. Questions which we consider of sufficient interest to our readers will either be replied to under "Answers to Correspondents" or replies will be invited from our readers. One shilling will be paid for the question which we select for competitive replies in this column.*

ANSWERS: *A fee of 10s. will be paid for the answer which we consider shows the greatest merit, and 5s. for the one we select as second best. In judging the replies, importance will be attached to clearness and conciseness, as well as accuracy. The Editor reserves the right to make no award, or to accept only one reply, if, in his opinion, the answers received do not possess sufficient merit. Competitors desiring the return of their manuscripts, if unaccepted, should enclose stamped addressed envelope.*

Write on one side of the paper only, and if diagrams are sent, draw them on a separate sheet of paper attached to the manuscript. Competitors may adopt a "nom de plume," but, both in the case of questions and answers, the competitor's real name and address must be sent with the manuscript as a guarantee of good faith. No correspondence will be entered into with regard to successful replies. The Editor's decision is final.

Commencing with Question No. 101, a Diploma of Merit will be awarded to the six competitors who win the first or second prize the most times during the next twelve months.

The words "Questions and Answers" or "Q" and "A" should be placed at the top left-hand corner of all letters intended for this column.

QUESTION No. 153.

Is the old Marconi coherer suitable for wireless telephony receiving sets? If so, how can I adapt it for this purpose?—"B.B."

QUESTION No. 154.

I have a new accumulator enclosed in a celluloid case. Its capacity is 50 ampere hours. I notice that sulphating has commenced to take place, not on the plates, but on the bars which hold the plates together. Is this injurious? If so, how can I prevent it?

—"PAX."

(Replies to Questions 153 and 154 must be received not later than February 10, 1923.)

Answers to Questions.

REPLIES TO QUESTION No. 149.

The second prize (5s.) has been awarded to "L. R." for the following reply:—

The effect of short-circuiting or of open-circuiting one of the three phases of a three-phase induction motor depends largely on the particular characteristics of the machine, and also on the protective devices that may be used in conjunction with it. What is likely to happen can best be examined by consideration of the first principles of induction motors. A three-phase motor is a machine for providing uniform rotary motion from three series of periodic impulses. It may well be likened to a three-crank engine. Electrically an induction motor is practically a transformer; and especially at the instant of starting, transformer rules apply. Currents are supplied to the primary or stator windings, and induce currents in the rotor, which acts as a secondary. At any moment the ampere turns in the secondary or rotor are nearly equal and opposite in phase to the primary or stator ampere turns. They would be strictly equal and opposite were it not for two considerations, the magnetising component of current in the primary and the presence of magnetic dispersion. It is, therefore, clear that one cannot predict what will happen in one machine from considerations of what has happened in others, because the characteristics of the machines are not necessarily alike.

As a result of the interplay of the three currents in the three phases of the stator, there is generated a progressive, multi-polar field, the lines of which travel around at a high speed.

If now the machine is at rest and one of the phases interrupted, it is analogous to a three-crank engine with one connecting rod broken. There will be remaining two series of impulses not in phase, and these are sufficient to produce a shifting field, and therefore in most cases to cause rotation of the rotor. In the case of single-phase induction motors, a two-phase starter is often employed, but the windings are arranged in a manner different from a three-phase motor, so a single-phase motor with split-phase starter is not exactly the same as a three-phase motor with an interrupted phase. If the machine does start, it will continue to run, but not with a full power. If one of the phases be short-circuited, then, as regards starting, one still has the rotary effect of the other two phases; but it is necessary to take into consideration whether the protective devices will not entirely cut out the motor owing to the high current taken by the short-circuit, or whether the reaction will overpower the effect of the other phases. This largely depends on the particular motor and the particular protective devices used. No machine could run satisfactorily under these conditions.

If the break of the phase occurred when the machine is running, it would continue to run; but if a short-circuit occur on one phase when the machine is running, if the motor is properly protected the cut-outs will operate and the machine be brought to rest.

A classic paper on the rotary field produced by two oscillating fields gives a considerable amount of information which underlies induction motor principles, namely, "Electromagnetic Rotations," by Prof. Ferraris, Boletino Academica de Torino, 1887 to 1888.—"L. R."

NOTE.—The replies to this question were so good that our Competition Editor had considerable difficulty in awarding the prizes. Under these circumstances, we have awarded two second prizes of 5s. This, the second 5s., has been awarded to "W. G. White" for the following reply:—

The behaviour of an induction motor under conditions specified in problem will depend on whether the stator is connected in star or in mesh, so we will consider the following cases in order:—

(*a*) One phase short-circuited; stator in star.
(*b*) One phase short-circuited; stator in mesh.
(*c*) One phase interrupted; stator in star.
(*d*) One phase interrupted; stator in mesh.

(*a*) This will be equivalent to an open-delta method of connection. A rotating field will be produced, which will not be uniform in magnitude. Consequently, the machine will start up. But the whole of the line voltage will now be across each of two phases, and the e.m.f. induced must be such as to practically neutralise this applied voltage. The new value of the e.m.f. induced will, therefore, be approximately 1.73 × previous value, and since the frequency and number of conductors remain constant, there must be an increase of flux in this ratio. Assuming no saturation occurs, this will increase the magnetising current in the same ratio. But in all probability there will be considerable saturation, and the magnetising current required to produce 1.73 × original flux may be a tremendous amount. The effect of the current in the short-circuited phase will tend to produce demagnetisation (since it is produced by a counter e.m.f.), and this.

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again, will increase the magnetising current required. If this fault occurs when machine is working, the same conditions will apply.

(*b*) This would be a dead short-circuit across the mains, and would consequently blow fuses. The machine would not start up, therefore. If this fault develops when running, the fuses would blow and motor stop. If one fuse only blew, the machine would continue running as a single-phase motor.

(*c*) In this case there would be two phases in series across the line, and machine would therefore operate as a single-phase motor. Such motors are not self-starting, but will continue running if started in either direction. Should this occur when working, the machine will, of course, continue to run.

(*d*) This would be very similar to case (*a*), namely, open-delta method of connection, and machine would start up without the excess of current which would be experienced in (*a*), because the phases in this case are designed to operate at the line voltage.

The output of machine would be reduced to .58 of its original value on account of the limitations imposed by max. phase current.—W. G. WHITE.

THE AUTOMATIC DIRECTOR IN STROWGER METROPOLITAN TELEPHONE SYSTEMS.

Through the joint efforts of the research and development staffs of Automatic Electric Company of Chicago, and the Automatic Telephone Manufacturing Co., Ltd., of Liverpool, a new unit of automatic equipment, known as the director, is now available. The director, an assembly which consists of several pieces of standard Strowger apparatus, provides features which are sometimes very desirable in large and complex metropolitan exchange areas.

For economic and engineering reasons, the application of automatic operation to large metropolitan areas invariably involves a transition period, which may extend over several years. During this period it is necessary to provide means for handling four general classes of calls, *i.e.*, manual to manual, manual to automatic, automatic to manual, and automatic to automatic.

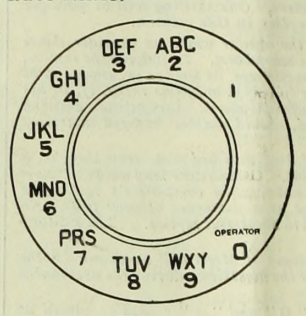


FIG. 1.

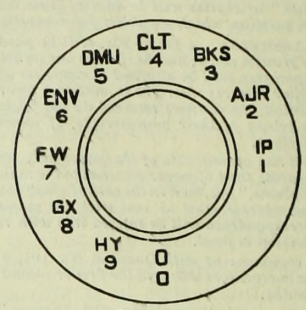


FIG. 2.

The director unit has distinct spheres of usefulness in increasing the flexibility and efficiency of operation in all four of these classes, and a brief description of its application in the last-named class (full automatic) should give an adequate idea of its adaptability.

In large metropolitan areas it seems desirable to identify each subscriber's station by means of an office name and four digits. To dial the desired station, it is the plan to "spell" the first two or three letters of the office name by successive turns of the dial, which "spelling" would be followed by the four significant digits of the called station's designation. It is apparent, therefore, that the dial must be marked with letters in addition to the digits.

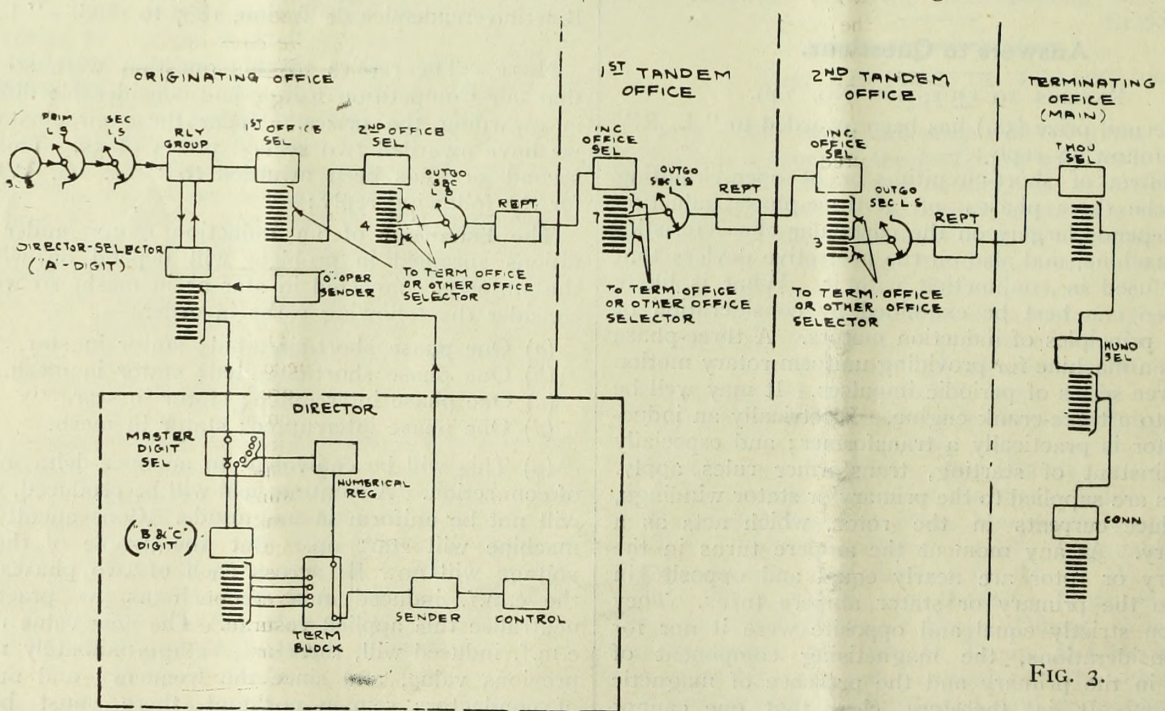


FIG. 3.

Two arrangements of dial lettering are shown in Figs. 1 and 2. Fig. 1 shows an arrangement that has been in use for some little time. With either plan, it takes the subscriber somewhat longer to locate letters than to locate numerals, but there seems to be no such difference in finding time between the two forms of lettering.

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So far, the use of the plan in Fig. 1 has demonstrated that while the spelling scheme is feasible, great care must be exercised in the selection of office names to avoid the possibility of confusion resulting from the subscribers' lack of familiarity with the spelling of any of the office names chosen.

It has also been demonstrated that many subscribers do not differentiate between the letter "I" (corresponding to the numeral 4 in Fig. 1) and the numeral "1": or between the letter "O" (corresponding to the numeral 6 in Fig. 1) and the numeral "0." This difficulty is accentuated by a practice, common to cities where arrangements are made for automatic numbering, of prefixing o's to the one, two and three digit numbers (all subscribers' numbers must have four digits), and instructing the manual subscribers as follows: "For Monroe 0032, ask operator for Monroe oh-oh-three-two," instead of "naught-naught-three-two." Under such circumstances it is inconsistent to expect such subscribers, when they use the dial, to differentiate properly.

The arrangement of letters shown in Fig. 2 overcomes this difficulty. It will be seen that, in this case, the subscriber need not differentiate.

In metropolitan areas it is sometimes desirable to retain certain existing office names that have some geographic or historic significance. In order that this may be done without regard to the established trunk routes, it is necessary to dissociate the numbering scheme and the trunking scheme.

This can be accomplished by means of the director, since arrangements are provided to register the impulses corresponding to the two or three letters of the office name, together with the insignificant digits of the call number, and to send out other impulses of such number and combination as are required to direct the call, link by link, over the proper trunk routes, to the terminating office; and there to operate the selectors and connectors as required to establish connection with the number dialed.

The director is attached to the circuit only during the setting up of the connection. When the connection has been established the director is cut out of the circuit, leaving only the equipment in circuit that is in circuit in standard Strowger exchanges.

The director equipment can be added to existing two-wire Strowger installations of the later types any time it may become desirable to dissociate the numbering scheme from the trunking scheme.

Director Functions.

The director-equipped Strowger metropolitan system (see Fig. 3) consists of primary and secondary line switches; one or more groups of office selectors; thousands selectors, hundreds selectors and connectors. It will be noted that between the secondary line switch and the first office selector there is an equipment group containing a director-selector switch, which in a three-letter office code system responds to the first pull of the dial and selects one of a group of directors. The second and third pulls of the dial are registered on a switch in the director.

Suppose the letters dialed are MAI for the office name MAIn. If the arrangement in Fig. 2 were used, this would have a numerical equivalent of 521. Upon the first pull of the dial, the director-selector switch would step to the fifth level, and select a non-busy director on this level. The director would then register 21 in response to the second and third pulls of the dial. The numerical registers in the director respond to the subsequent pulls of the dial and register the thousands, hundreds, tens and units of the particular call number. An additional register is used in cases where a party line designation is required for "jack per line" party line service.

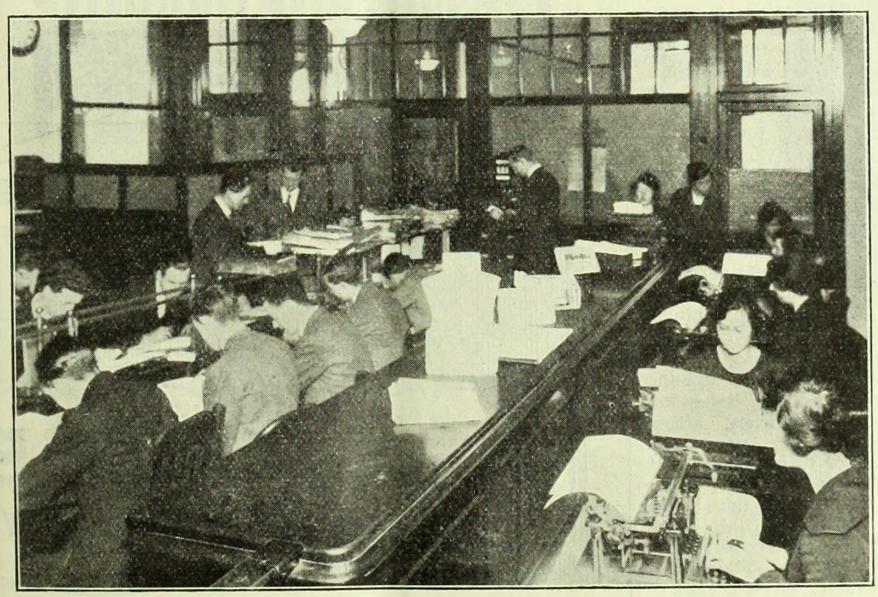
(To be continued.)

NEW BOOKS PUBLISHED.

"Mathematics for Engineers." Part II. By W. N. Rose. 2nd edition. Cl., 8vo, 423 pp., 143 illus. 13s. 6d. net.

"Radio Telephony for Amateurs." By Stuart Ballantine. Cl., 8vo, 296 pp., 156 illustrations. 7s. 6d. net.

"The Simple Lathe and its Accessories." Cr. 8vo, 152 pp., 171 illustrations, 1s. 6d net.



"WIRELESS" INSURANCE.

Our recent allusions to the need for insuring wireless sets were, we believe, partly instrumental in policies to cover such risks as fire, lightning, storm, tempest, burglary, third party claims, etc., being provided at a nominal figure by leading insurance companies. As already noted in these columns, the Liverpool Marine and General Insurance Co., Ltd., of 7, Angel Court, Throgmorton Street, E.C.2, appear to have been first in the field with this class of insurance, and their compliment to the wireless industry and the increasing interest of the public has been rewarded by a "boom," as evidenced by the annexed photograph, which represents their staff working on the policies.

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Various Items.

The Mumbles.—The Electricity Commissioners are being asked to sanction a loan of some £13,500 for the provision of a supply from Swansea.

East Africa.—According to the report on the trade and commerce of East Africa, which has just been issued by the Department of Overseas Trade (1s. 9d. net, post free), during the nine months April to December, 1921, electrical apparatus was imported into that great territory to the value of £15,700 from the U.K. and £2,900 from the U.S.A.

The N.A.S.E. Dinner.—It looks as if this year's dinner and concert of the National Association of Supervising Electricians will be a bumper gathering. It is to be held on Saturday, 17th inst., and many of the important firms in the electrical industry have intimated their intention of being present or represented, as also have many well-known gentlemen, including Mr. J. S. Highfield, Sir T. Callender, Mr. F. Gill (President, I.E.E.), Sir Burton Chadwick, M.P., Mr. A. H. Dykes, etc., while Mr. W. E. Highfield, President of the N.A.S.E., will occupy the chair.

"**Motion Picture Projection.**"—This is the title of a text-book for kinematograph operators, which was written by Mr. James R. Cameron, the technical editor of several of the leading American film journals. As such, it contains a large amount of matter of direct interest and value to men engaged in such work in this country, and there are 228 illustrations covering quite a large amount of ground, both electrical and optical, together with a glossary of technical terms, and forty pages of questions and answers covering a very wide ground. The price is 21s. net, post free, from ELECTRICITY Office.

British Industries Fair.—We have received from the Department of Overseas Trade an advance copy of the official catalogue of this undertaking, which will, as before, be held at the White City and in Birmingham. The former is confined mainly to light goods, such as chemicals, fancy goods, stationery and pottery, while the Birmingham Section, organised by a joint committee of the Municipality and the Chamber of Commerce, will display heavier commodities, such as engineering stock, electrical apparatus, hardware and tools. A quarter of a million invitations to trade buyers in the U.K. are being issued by the Department, and another 50,000 have already been sent to buyers overseas. The Fair has also received considerable publicity overseas, and a highly satisfactory number of buyers have written to the Department expressing their interest and intimating their intention to attend. In many of these replies overseas buyers have raised questions of interest to themselves and British manufacturers, and as a result orders for British firms have already been secured. Some idea of the size of the Fair and the labour involved in its preparation may be gained from the fact that at the White City alone there will be some four miles of stand frontages, while the electrical fittings employed in lighting this city of wholesale shops call for the use of no less than a dozen miles of ordinary cable, a dozen miles of flexible cable, over a hundred fuse-boards, and six miles of straining wire to support the cable. By these means the 8,000 lamps on exhibitors' stands are supplied with current. In a few days representatives of the exhibitors will be busy putting the finishing touches to their displays in preparation for the rush of buyers, which will begin on February 19th.

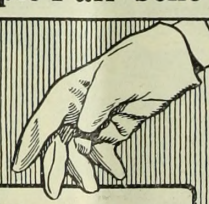
Tenders Invited.—Tenders are invited by the Public Works Tenders Board, Wellington, N.Z., for the supply of 400 miles (1,047,600 lb.) of hard-drawn bare copper wire required for Section 73 of the Mangahao Electric Power Scheme.—— Tenders are invited by the Postmaster-General's Department, Sydney, N.S.W., for the supply and delivery of telephone switchboard parts, including cables, condensers, cords, alarm fuses, keys, holders, jacks, ceiling lamps, plugs, relays, sockets, switches and insulated wires.—Also, the Postmaster-General's Department, Hobart, Tasmania, invites tenders for the supply and delivery of telegraph and telephone material, including magneto bells, timing clocks, detectors, hand sets, galvanometers, keys, lamps, mouthpieces, plugs, sockets, rotary snap switches.——The State Electricity Commission, Victoria, Australia, invite tenders for transformers and spares and also for transformers only.——Tenders are invited by the Postmaster-General's Department, Melbourne, for the supply and delivery of 595 clocks for timing telephone trunk lines, 5,100 receiver diaphragms, 686 tons bronze wire, 400,000 copper jointing sleeves, 5,001,000 paper jointing sleeves.——The Municipal Council of Johannesburg invite tenders for electric cables. Owing to limited time available for reception of tenders, this information may be of use only to those firms who are in a position to cable instructions to their local agents.——The State Electricity Commission of Victoria invite tenders for motors, starters and isolating switches for the Yallourn Briquetting Works.——The Postmaster-General's Department, Adelaide, invite tenders for telephone apparatus.——The Australian Commonwealth Government invite tenders for the supply of 16,750 Leclanche porous cells and 1,200 earthenware outer jars. Specifications, etc., may be seen on application to the Enquiry Room of the D.O.T., 35, Old Queen Street, S.W. 1.

Meetings.—The Junior Inst. of Engineers will meet at 39, Victoria Street, S.W. 1, on Friday, 9th inst. Hon. Members' Lecture, "The Effect of Temperature on the Properties of Engineering Materials," by Prof. F. C. Lea, D.Sc. (slides). Also on Friday, 16th inst. Lecturette, "Notes on Some Insulating Materials," by T. L. Allison (Member)—both at 7.30 p.m., and on Sautrday, 17th inst., at 2 o'clock, there will be a visit to buildings in course of construction at Wembley for the British Empire Exhibition.——The next monthly meeting of the Birmingham and District Electric Club will be held on Saturday, February 10, at 7 o'clock, at the Grand Hotel, Colmore Row, when Mr. J. W. Beauchamp, M.I.E.E. (Director of E.D.A.), will speak on "Advertising and Salesmanship in Relation to the Electrical Industry."——The I.E.E. (Scottish Centre) will meet at the Rooms, 207, Bath Street, Glasgow, on Tuesday, 13th inst., at 7.30 p.m. Paper: "Some Problems in High-speed Alternators, and their Solution," by J. Rosen.

"**One Summer's Day**" proved to be a very enjoyable evening at King George's Hall, Tottenham Court Road, on Friday, the 2nd inst., when the dramatic section of Henley's Head Office Social Club gave a really excellent rendering of Mr. H. V. Esmond's charming comedy. It was well staged, and the acting was very good indeed. Much credit is due to Miss Dorothy Josling (Maysie) and Mr. Trevor Wheeler (Maj. Dick Rudyard) for the free and easy way in which they performed their respective parts, while Mr. W. A. Moore, as the stern uncle, was a character in himself. Tom caused considerable amusement in the way he handled the punt-pole and narrowly escaped a ducking, while Miss Netta Taylor made a first-class urchin whose interest in worms—and finance—added to the general brightness of the show. Altogether a real Henley evening. Mr. Rosling, Mr. Potter, Mr. Salmon, Mr. Bishop and many other well-known members of the firm were present, together with their wives, sisters, aunts, cousins and sweethearts, and all expressed their unbounded satisfaction with the way in which the play was produced by Mr. Henry Thornton, and also with the musical selections so ably rendered by the Audbrook Trio under the direction of Miss Frances Woodbridge.

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A POPULAR SCIENTIFIC WEEKLY JOURNAL
ELECTRICITY
A PRACTICAL TRADE JOURNAL

FEBRUARY 16, 1923.

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A PREMIER BROADCAST RECEIVING COMBINATION.

In a market which offers such a variety of types of listening-in apparatus, and at prices to suit all pockets, the possessor of a broadcast receiving licence without experience of the possibilities of the new pastime must necessarily find some difficulty in deciding what apparatus will best suit his needs and give him the utmost value on his outlay.

In considering this question the principal determining factors are:—

(*a*) Efficiency.
(*b*) Scope of reception.
(*c*) Simplicity of control.
(*d*) Price.

We mention price last in order of importance because, although the average person's broadcasting ambitions are to a certain extent governed by the amount he or she can afford to spend on a receiving set, price is of lesser importance by comparison with the first three factors, and if one is getting value for money as represented by (*a*), (*b*) and (*c*) above, the price paid, within limits, is a secondary consideration.

Available broadcast receiving sets may be broadly classified under two main heads, (1) crystal sets, the simplest and cheapest possible apparatus, which require no battery, but suffer from the disadvantage that reception is confined to the headphone form of receiver, and (2) valve sets, which indefinitely extend the range of reception according to the number of amplifying valves employed, and, further, by magnifying the received energy, enable a loud speaking receiver to be used in combination with them, thus dispensing with the individual headphone and its drawback.

In view of the intimate association between wireless and ordinary "wire" telephony, from the apparatus standpoint, it was natural that the leading British telephone manufacturers should be among the first to cater for the requirements of the "listening-in" public. In this connection, Automatic Telephone Mfg. Co., Ltd., Milton Road, Edge Lane, Liverpool, the British manufacturers of the original Strowger automatic telephone equipment, which has been adopted by the British Post Office in Leeds, Portsmouth and several other provincial telephone exchanges, speedily realised the possibilities of the new industry, and when the broadcasting scheme was first mooted they at once commenced to manufacture crystal detector sets and headphones, together with other lesser accessories likely to be in demand.

As regards headphones this company was eminently

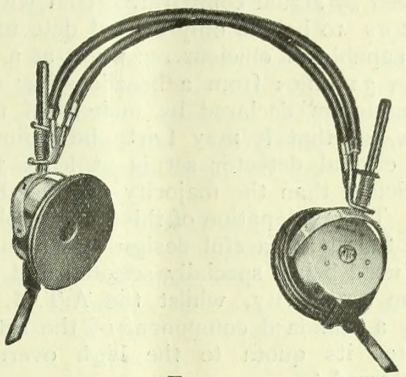


FIG. 1.

adapted by years of experience in design, as well as by its unique manufacturing facilities, to enter on mass production, and that the highest efficiency and finish can be combined with rapidity of manufacture is evident from the fact that A.T.M. long-distance radio headphones are now generally accepted as the best and most efficient on the market, and as such have been adopted as standard components by other leading makers of radio apparatus.

A.T.M. radio headphones are scientifically designed, have a high effective impedance, and strong permanent concentrated field. Withal they are compact, exceptionally light in weight (8½ oz.), instantaneously adjusted to the ears, and comfortable in prolonged wear.

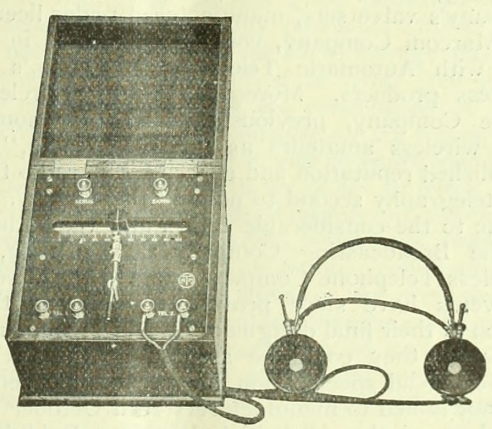


FIG. 2.

Either receiver can be readily detached from its supporting stirrup at will, and used independently, thus enabling two persons to listen-in on the same headset should they so desire. A typical A.T.M. headphone is shown in Fig. 1.

The A.T.M. crystal detector set, Fig. 2, was another early success which emerged from the mass of cheap and, in many instances, useless crystal sets with

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which the market was flooded at the outset. Although the simplest and cheapest form of broadcast receiver, even a crystal set, to be really efficient, must embody correct scientific principles and the most rigid inspection and testing, both in its design and subsequent bulk manufacture. That all these necessary qualities have been combined in the A.T.M. crystal detector set may be gauged from the fact that, with one exception, that of a very much more expensive production, it has proved by actual comparative trial with its leading competitors to be the only crystal detector set on the market capable of efficient reception at a range of no less than 32 miles from a broadcasting centre. The usual maximum declared by makers of these sets is 25 miles, so that it may fairly be claimed that the A.T.M. crystal detector set is at least 35 per cent. more efficient than the majority of crystal sets on the market. The explanation of this remarkable superiority is to be found in careful design and manufacture, all crystals used being specially selected and mounted for maximum sensitivity, whilst the A.T.M. headphone, which is a standard component of the set, of course, contributes its quota to the high overall efficiency above referred to.

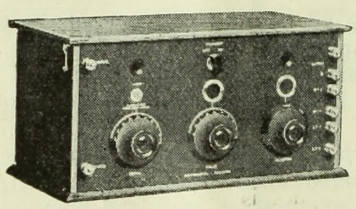


FIG. 3.

In the matter of valve receiving sets, Automatic Telephone Mfg. Co. speedily realised the desirability of combining forces with some concern of experience and established repute, and to this end an arrangement was entered into with Ashley Wireless Telephone Co., Ltd., 69, Renshaw Street, Liverpool, whereby that company's valve sets, manufactured under licence from the Marconi Company, could be marketed in conjunction with Automatic Telephone Mfg. Co.'s existing wireless products. Moreover, Ashley Wireless Telephone Company, previously trading for some years with wireless amateurs as "Ashley Radio," had an established reputation and experience in radio telephony and telegraphy second to none in the country.

Due to the considerable delays and vacillating policy of the Broadcasting Company during 1922, Ashley Wireless Telephone Company adopted the wise course, as events have since proved, of delaying the completion of their final designs of broadcast valve receiving sets until they could be assured of the permanence of the official specification for permissible sets. This was not issued to manufacturers until October 10, after the close of the All-British Wireless Exhibition and Convention, held at the Horticultural Hall, and to the surprise, and doubtless dismay, of those manufacturers who had already committed themselves to definite programmes of production on earlier designs, it raised the embargo on wave-lengths previously limited to 400 metres, and, moreover, permitted the inclusion of limited reaction, if applied in such manner as not directly to affect the aerial. These concessions permitted the production of apparatus some 50 per cent. higher in efficiency than was possible under the prior specification, and Ashley Wireless Telephone Company at once set about designing and standardising the manufacture of valve sets embodying these new factors in the highest degree.

As a result they are now marketing Ashley 2-valve and 3-valve broadcast receiving sets, together with a separate 2-stage low frequency amplifying unit, which, in combination with either of the two first-named sets, gives a 4-valve and 5-valve equipment respectively, and not only brings all British broadcasting stations within range, but Paris, The Hague and other Continental stations in addition, as well as furnishing sufficient energy for effectively operating a loud speaker, thus rendering both music and speech clearly audible to a number of people in the same room, and obviating the necessity for headphones.

The Ashley 2-valve set illustrated in Fig. 3 embodies one H.F. amplifying valve and one detector valve. The Ashley 3-valve set embodies two H.F. amplifying valves and one detector valve. Both sets are equipped with interchangeable aerial tuning coils and H.F. transformers in four standard wave lengths, and permit of tuning up to 3,000 metres. They are fitted with readily adjustable reaction coils, and tuning is otherwise by adjustable condensers, the necessary controls being reduced to a minimum. The ebonite panels of all the sets, including the amplifying unit, are removable, thus exposing all fittings, valves and wiring for close inspection and adjustment when necessary; coupling of the units is effected by links supplied with them, and the terminals are conveniently arranged to facilitate this.

Fig. 4 illustrates the Ashley 2-stage low frequency amplifier.

In view of the general demand for an efficient loud speaker, Automatic Telephone Mfg. Co. instituted special research into this fascinating and complex problem. To this end they established as existing

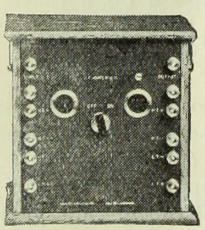


FIG. 4.

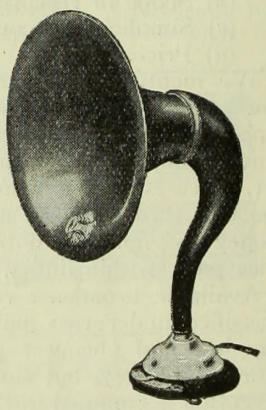


FIG. 5.

standards in their well equipped laboratory specially selected models of all the then existing popular types of apparatus, both British and American, and declared their intention of producing something better still, which could yet be sold at a competitive price to bring it within reach of the general body of licence holders.

That they have succeeded and produced a piece of apparatus which for volume, clarity and purity of musical tone exceeds all others is evident from the tremendous appreciation expressed by users generally, and the trade in particular, of the A.T.M. "Claritone" loud speaker, Fig. 5. As its name implies, the

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"Claritone" faithfully reproduces every musical note and every inflection in the voice of a broadcasting speaker. It has even been known to reproduce studio "asides" when a broadcast operator has not been overcareful in his conversation with a friend or assistant.

It is claimed by the makers that not only is the "Claritone" loud speaker the best in the world, but that it yields results more than equivalent to an additional valve in the receiving circuit.

If we were asked to name the best and most efficient broadcasting receiving combination on the market we should unhesitatngly vote for an Ashley 2-valve or 3-valve set, coupled with an Ashley 2-stage low frequency amplifier and an A.T.M. "Claritone" loud speaker.

Incidentally, Ashley Wireless Telephone Company have been appointed sole distributing agents for Automatic Telephone Mfg. Co.'s wireless products, and their new illustrated price list is now available on application to the nearest retail agents, or direct to their head office, 69, Renshaw Street, Liverpool.

WORKS PRODUCTION.

During the past two years a great deal has been written about production problems. Some of which have been penned by idealists, who claim, for instance, that such and such a shop lay-out is the first essential to successful production. Others emphasise that lack of production is caused by "ca' canny" amongst the workers. The bearing of these factors upon production, or the lack of it, can be dealt with by efficient organisation and management, and it is with the establishment of such a works organisation that the paper on this subject by Mr. G. H. Nelson, recently read before the I.E.E., deals.

With a view to interesting all sections of the industry, the author has dealt with the subject on general lines, with particular reference in places to the manufacture of electrical machinery, the object being rather to outline a general policy that has been followed in works with which he has been associated (the large works of the Metropolitan-Vickers Electrical Co., Ltd., at Trafford Park), than to go into detail which may not be applicable to any other works, as, naturally, detail must be based on the equipment in a particular works and the design of the apparatus manufactured.

As he pointed out, the fundamental for the organisation of economical production is co-operation. A shop with a good lay-out, manufacturing good designs, does not necessarily produce cheap and good articles. There must be the closest co-operation between all sections of the staff and workmen before any real success can be achieved. The basis of co-operation is naturally the human element in all branches of the organisation, and the amount by which the ideal is approached is controlled by the results obtained by the weakest human link. This is fundamental, and the author personally considers it to be of first importance. The heads of factories must first be students of human nature, so that in selecting men for executive positions they can satisfy themselves that these men, in addition to thoroughly understanding the technical and practical sides of their respective appointments, can also select and lead their subordinates to co-operate with other sections or branches of the works.

The special problem of the manufacture of electrical apparatus is so complex that it really cannot be left to haphazard methods, for there is no apparatus made in which there is a greater variety of materials. For example, in a standard design of rotary converter, there are 4,582 separate parts, not including nuts, bolts, washers and rivets, which account for a further 1,248. There are also 55 different materials used.

The success achieved by the system which was described is shown by the following:—

(1) The relations between the total value of the work in progress and the value of the monthly output of completed machines was reduced from 7 months to 4½ months, thus giving a very considerable saving in capital required and the interest on that surplus capital.

(2) The average time of manufacture of a certain size of machine was reduced from 22 weeks to 18 weeks, and that of other sizes relatively. This has since been still further reduced, and this is accounted for by the fact that the shop is not now fully employed.

(3) The number of machines overdue was reduced two-thirds.

(4) The number of defects arising during manufacture on various operations has been reduced two-thirds.

(5) The accumulative effect has reduced the cost of manufacture by quite a considerable percentage.

The author then deals with the general lines of the system, but space is not available for us to refer to this in full, but the following extracts should prove of value. It is pointed out that the most important item in works superintendence is that of labour. In order to handle this problem efficiently, all those who have the handling of labour must be satisfied in their own minds that the biggest percentage of workmen are reasonable men, and if this good percentage have rather distorted ideas on any particular subject, they should not be blamed but helped to change their distorted views. Problems looked at from their limited outlook can easily produce the conclusions at which they arrive. When these conclusions are wrong, it is the duty of all employers of labour to endeavour to put before their employees both sides of the problem. The problem then often resolves itself largely into the elimination of selfishness from all parties, employers, employees and employees' unions. The author, personally, has the greatest respect and affection for the working classes as a whole, but he realises that the vast majority are not in a position, through lack of knowledge, to consider the problems with which they are faced, and therefore simply accept the teachings of loquacious agitators.

The importance to all in industry, and to the nation as a whole, of improving the position as regards works education is apparent to those in close touch with the workers, and the future can be best taken care of by the proper provision for the training of apprentices. In this training, apart from their ordinary trade, there should be included lectures on economics. How few workmen realise what the secretary of a leading trade union recently pointed out, namely, that 90 per cent.

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of the costs of production is borne, indirectly, perhaps, but nevertheless borne, by the workers themselves! With regard to technically trained men, it is rightly pointed out that our universities and technical schools should include in their curriculum a course of economics. Lectures should also be given on the relation between so-called capital and labour, and, further, methods of costing, time-keeping and absorption of overhead expenses should be dealt with. The development of initiative should also have special attention, for when men enter into ordinary industrial or business life, very few have to apply solely technical knowledge. The technical knowledge acquired is very often only a means to an end in so far that it enables one to think on the right lines. Men should be encouraged to take part in open discussion on technical and other subjects, to give them confidence in themselves and to develop their personality. Success depends largely on one's executive acumen, initiative and ability to co-operate.

The author has found the setting up of a works committee to be the most effective way of establishing confidence between the management and the men. It is a most satisfactory channel for bringing before the workers the management's views on all sorts of questions, particularly managerial and labour problems. Further, it enables the management to obtain the workers' views. This gives the workers the feeling that they are being consulted in matters in which they are directly interested, and this in itself removes suspicion. It must be appreciated that economic production can never be obtained unless the men give loyal support to the management. In this connection the author would say that the value of the works committee's support and assistance in the introduction of the system outlined in the paper contributed largely to the success of the system. This should be ample evidence of the value of a works committee, for if there is one thing that tends to create suspicion and upset the workmen more than any other, it is a change of management and system.

In order to stimulate the foremen's maximum interest in the management of their shops and keep them informed on economic and managerial problems, the author has found that monthly foremen's meetings, at which all problems of general interest met with during the previous month are discussed, are of great assistance. The foremen have continually referred to the value of these meetings and to the fact that by this method they have received information on matters which, in the past, have not reached them at all.

The question at the bottom of much labour trouble being the fear of unemployment through lack of trade, it is interesting to note that the author has introduced a system on the lines of "insurance by industry," and it will be instructive to note how it works out in the long run. Although in some works day work is the rule and is found to give satisfactory results, in the M.-V. works they work on the "payment by results" scheme (and this certainly appears to be giving every satisfaction to the employees and the management). The scheme in vogue is based on a sinking fund, and the following is the author's description and notes on its application to day work:—

"In the engineering industry agreements already exist by which a pieceworker of average ability must be able to earn 33⅓ per cent. bonus. Most workers by extra effort earn considerably more than this. It would therefore be quite feasible to base this 'unemployment sinking fund' on this extra effort, by the employer suggesting that for every 1 per cent. earned by the worker over the 33⅓ up to 50 per cent. he will give a fixed sum per 1s. to the fund, provided that the employee will also give a fixed sum per 1s.; and further, for every 1s. over 50 per cent. bonus the employer would give a further extra contribution in order to promote extra effort. It will be seen that the employer would thus be giving extra payment for extra effort, such money to be applied to insure the worker in times of plenty against times of depression.

"The scheme could be applied to the recognised day workers, such as crane men, shop labourers, etc. The same effort could thus be obtained from all employees of the firm to assist the pieceworker in the production of his maximum bonus. The piecework prices would be set to a recognised scale which could be easily seen. If deemed advisable these unemployment funds could also be used for old age and sickness benefits.

"It was pointed out to the author by a workman that many men would be suspicious of the scheme because they would think that employers would know how much money the worker had saved in this way, and would use this knowledge to their own advantage in times of depression, or other times. In order to overcome this, the fund might be administered solely by the various works committees or district committees, and thus the employer would have no knowledge of the sums accumulated for any individual. This fund would be available solely for periods of unemployment due to causes other than industrial disputes, it being clearly recognised that an employer could not reasonably be expected to contribute to funds which might at some future period be used for strike purposes. The details of a scheme of this description must necessarily be bound up in a certain amount of trust between employer and employee, and this can be dealt with through the works committee."

In conclusion we would refer to one matter—the fact that increased production means greatly decreased cost and increased profits, or a profit instead of a loss. Should anyone doubt this we would ask them to read the original paper and the full discussion as soon as this is available. The Institution is to be congratulated on admitting such a paper as this, and now that a beginning has been made here, coupled with the fact that we have also an Institution of Production Engineers, there is every hope that the vexed problem is on the high road to settlement on business lines of industry, instead of politicians.

Meetings.—The Inst. of Production Engineers will meet at 7.30 p.m. on Friday, 23rd inst., at the Engineers' Club, Coventry Street, London, W. 1. Paper: "Machine Moulding Methods," by Mr. T. F. Hardyman (slides). All interested are invited to attend, whether members of the Institution or not. ——The Illuminating Engineering Society will meet at the Society of Arts (John Street, Adelphi, London), at 8 p.m. on Tuesday, 20th inst., when a discussion on "The Projection of Light" (lanterns, kinema projectors, floodlighting, etc.) will be opened by Mr. W. J. Jones and Mr. E. A. Marx, jun.—— The inaugural meeting of the St. Bride Radio and Experimental Society will be held in the large hall of the St. Bride Foundation Institute on Wednesday, 21st inst., at 7.30 p.m., when the President, Capt. H. Riall Sankey, will open the proceedings with a short address, to be followed by a demonstration and general meeting. Visitors are cordially invited to attend and take part in the proceedings.

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OSRAMS ABSORB CURRENT.

Of course they do, because the Osram-G.E.C. Lamp Works claim that there are more Osram lamps in use in Great Britain than there are of any other make, and, by Jove, the works staff can absorb good fellowship. They absorb it wholesale, and then return it with compound interest in the shape of hospitality at their annual dinner. Last Friday they held the usual festive gathering at the Café Royal, when Mr. Chris Wilson presided over about 230 keen-looking and enterprising members of the staff and friends. It was a very happy evening, with a capital dinner followed by an excellent musical entertainment, in which Miss Marion Ruth and Mr. Fred Rome visited an imaginary football match, and also endeavoured to engage an imaginary housemaid. Miss Doris Cowan sang charmingly. Mr. Hector Gordon gave us some "canny impressions," and Messrs. Fred Curtis and Clay Thomas also added to the enjoyment with songs and humour. As usual, the oratory was commendably brief. Mr. P. Maskell proposed "The Firm" in a happy speech, in which he referred humorously to his early days in the Lamp Works office, and incidentally accused the directors of being directly responsible for the great increase in the population of Hammersmith, a sally which evoked much laughter. Mr. Max Railing responded, and promptly repudiated any responsibility for the increase referred to, after which he went on to say how pleased the directors were to find that the staff appreciated the efforts made for their welfare, and how much the mutual co-operation assisted in general efficiency. He added that the managers had themselves started at the foot of the ladder, so could sympathise with their employees, and then went on to cheer us up by telling us of the quiet but really sound improvement in the trade outlook. Mr. G. Chelioti said various nice things about the visitors and the Press, and in regard to the former he mentioned some laughable incidents which had occurred in making inquiries from the research department. Mr. Fletcher responded for the visitors in a speech which continued the vein of optimism on the condition of business generally; and Mr. Rentell, who spoke for the Press, referred to the wonderful growth of these gatherings from the early days of Brook Green. Mr. F. Smith proposed "The Chairman," whom he eulogised in a fitting manner as the controlling spirit in the most up-to-date lamp factory in the world; and Mr. Wilson expressed his thanks, as well as his keen appreciation, of the good team work of all the departments. During the evening Mr. Hirst, Sir Wm. Noble and Mr. A. M. Sillar came along from another function, and an immediate call was made for a speech from Mr. Hirst, who expressed his pleasure at being present, and made us all laugh at his experience when lunching at the Clarendon as an unknown client, and the awe of the waiter who was not aware that he (Mr. H.) had the honour of being acquainted with Mr. Wilson's son-in-law (Mr. Driver) and his wife. Cordial votes of thanks to the stewards, Mr. Adams and Mr. Vanhinsenberg, for the successful arrangement of the dinner, terminated a very pleasant evening.

THE I.E.E. DINNER.

Another milestone has been passed in the life of the Institution of Electrical Engineers, and, as usual, the annual dinner, held at the Hotel Cecil on the 6th inst., was attended by various gentlemen eminent in the political and scientific worlds, as well as by a very large number of members and their friends. Mr. Frank Gill, our president, received the guests in his usual quiet and unassuming manner, and after the loyal toasts he read a letter from H.R.H. the Prince of Wales regretting his inability to attend, but hoping to be present on a future occasion, an announcement which was received with much enthusiasm. Sir William Joynson-Hicks proposed "The Institution" in very flattering terms, and impressed on his hearers the great commercial advantages which accrued to this country through the training of overseas students in our colleges and workshops. In his opinion, each such trained student, on his return to his motherland, was equivalent in value to ten ordinary commercial travellers as an outlet for British commodities. Our president replied, and, after alluding briefly to the growth of the institution, he went on to speak of the need for amalgamation in the electricity supply interests, and the difficulties which faced international telephony in Europe.

Mr. J. S. Highfield, past-president, welcomed the numerous guests of the evening, and coupled with the toast the names of the Right Hon. Neville Chamberlain, M.P., Postmaster-General, and Sir Arthur Colefax, K.B.E., K.C., both of whom replied, the former making special reference to the enormous possibilities of the future in regard to wireless telegraphy and telephony. Many of the inventions of the past had been made by great Englishmen, and he thought we might look forward to the future with equal hope. In order to render the speeches audible in all parts of the room, there was an installation of the "Public Address System," in which a sensitive microphone is placed on the table in front of the speaker, who delivers his remarks in the ordinary way. From the microphone the speeches were transmitted by cable to amplifiers, and then delivered through projectors placed about 20 ft. above the floor and focussed in three different directions. We believe the result was quite satisfactory to those seated at a distance from the speakers. After the banquet there was the usual reunion in the Victoria Hall, when old friends met and chatted and passed the time of day generally.

Meetings.—The Junior Inst. of Engineers will meet at 39, Victoria Street, S.W. 1, on Friday, 16th inst. Lecturette. "Notes on Some Insulating Materials," by T. R. Allison (Member). Slides and exhibits. Also on Friday, 23rd, Lecturette, "Characteristics, Operation and Maintenance of Underground Cables," by A. J. Tracey (slides); and on Friday, March 2, Lecturette, "Glass-forming Machines," by C. Saxton (Member). Slides. All at 7.30 p.m.

Tenders Invited.—The Victorian Government Rys. invite tenders for the supply and delivery of one electric hoist with trolley for the Newport workshops (Contract No. 35,793). Specification, etc., at the D.O.T.——The Victorian Rly. Commissioners invite tenders for a D.C. motor of 20 b.h.p., starting apparatus and accessories. Specification at the D.O.T.——The Victorian Rly. Commissioners require two sets of three-phase A.C. induction motors of 20 b.h.p., starting apparatus and accessories. Specification at the D.O.T. (Room 49), 35, Old Queen Street, Westminster, London, S.W. 1.

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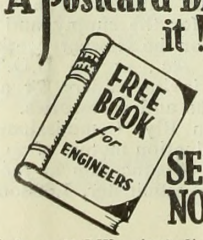
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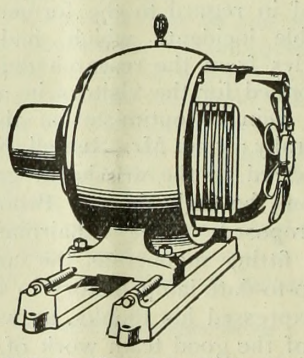
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TO OUR READERS.

ELECTRICITY is published every Friday, and, if ordered, is on sale at the principal Railway Station Bookstalls and Newsagents on that day. It has a very large sale throughout the United Kingdom, as well as in the British Colonies and Abroad.

Questions to which an answer is required must be accompanied by a 1½d. stamp for reply. When considered of sufficient interest, the answer will probably appear in the paper.

New advertisements for the displayed columns and alterations to existing ones must reach the publishing office not later than first post Tuesday morning, in order to be in time for the issue of the following Friday. This is important. Rate quoted on application. Subscription: 13s. a year, 6s. 6d. half year, 3s. 3d. a quarter in advance, postage prepaid in the United Kingdom and abroad.

All remittances payable to the Publishers, S. RENTELL AND CO., LTD., 36 39, Maiden Lane, London, W.C.2. Telephone No. 2460 Gerrard.

AN APOLOGY.

We regret very sincerely the delay in the issue of our "Practical Electrician's Pocket Book for 1923." This is due to an unfortunate dispute in the bookbinding trade, over which, of course, we have no possible control, and we can but ask for the patience of our numerous clients, who have written us asking when it may be expected. They can rest assured that it will be published as soon as the present trouble has been settled.

Current Topics.

Advertising and a Moral.

Recent personal experiences, coupled with those of a friend, in the matter of newspaper advertising, prompt this note and advice to those enterprising firms who spend much money and exercise considerable ingenuity in making their goods known to the public through the medium of the advertisement columns of the daily and weekly Press. I have had occasion during the past three weeks to answer three prominent announcements appearing in a well-known daily. The first application I sent in was for a descriptive pamphlet concerning the manifold uses of a certain raw material which was the subject of the advertisement. I wrote on the day the advertisement appeared, viz., January 22, and up to the time of writing these notes have received no reply. Now, the cost of the announcement referred to was of the order of £1,200, and if my experience is anything to go by, the firm responsible for its insertion must have lost a considerable percentage of the value of the publicity sought, due to lack of promptitude in dealing with inquiries.

My second application, arising out of an advertisement in the same daily, brought me a descriptive pamphlet by return post, and in due course I placed an order and sent my cheque for the goods, asking for prompt delivery. I received an acknowledgment, and delivery was promised in three days. It is now a week ago since that promised date fell due, and I have not yet received the goods, which are nevertheless still being advertised. In yet a third case, also a small ad., in the same daily, I sent an order on the same day as the announcement appeared, and again it was six days before the goods or any acknowledgment arrived. Now for my sequel: My friend ordered goods as per a small display advertisement in ELECTRICITY, and received them *by return post.*

The moral of these experiences is that advertisers have not yet learnt the golden rule of Press publicity, viz., that it is of no earthly use advertising unless you have the goods ready to distribute and in sufficient quantity to satisfy the demand likely to accrue as a result of the advertising campaign. Unless immediate stocks are held and plans made in advance for dealing promptly with the orders and inquiries which inevitably follow judicious advertising, you may just as well keep the money in the bank, or invest it otherwise. To advertise before your stocks are ready is suicidal, and thousands of pounds are being wasted in this manner, which, given proper organisation and a preliminary building-up of stocks, would have repaid the advertising investment a hundredfold. My advice to manufacturers is: Advertise freely, but first be prepared to deliver the goods.

Broadcasting and a Bad Policy.

Certain firms interested in the sale of receiving apparatus for broadcasting are conducting what amounts to an advertising campaign by public demonstration. Apparatus and aerial are installed, and an operator furnished on the occasion of big public dinners and other functions likely to be attended by influential people. Broadcast reception is made a special feature of the evening, usually during an interval in the toast list, or possibly as an item in a musical programme provided on the spot. The idea underlying such a scheme is, of course, to advertise freely the possibilities of the new pastime, and make them known among people who have no idea of what broadcast reception is like. So far, so good, and, if the circumstances were favourable, no finer means of publicity could be found.

Unfortunately, however, the venue of these public demonstrations, and the local conditions under which they necessarily have to be given, always militate against really good reception and the result in 90 per cent. of cases is disappointment and disillusion for that particular body of people who happen to be listening-in. I was a guest at one of these functions in the North of England only last week. An important dinner was being held in one of the leading city hotels, and during the evening a demonstration was given of broadcast reception from London. The apparatus was switched on for a brief five minutes or so in an interval between speeches, and, although the result was audible throughout the large dining-hall through the medium of the two loud-speaking receivers employed, the announcements from Marconi House were quite unintelligible, nor was the subsequent vocal selection at all musical, resembling, in fact, a very poor gramophone reproduction.

The cause is not far to seek, and exists to a greater or lesser degree in all similar instances. In this particular case the hotel itself is a steel frame structure, fully equipped with electric light, lifts and other electrically driven accessories. In addition, the terminal station of an electric railway adjoins, and electric tramcars pass the front entrance. In the circumstances is it to be wondered at that good reception was unobtainable? The remarkable thing to my mind is that any results at all were secured. The fact remains that between four and five hundred potential customers for broadcast receiving sets must have been hopelessly disillusioned, whereas, had they been given a private house demonstration under the favourable conditions ordinarily obtaining in suburban or country districts, the impression created in their minds would

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have been precisely opposite to that with which they actually left the one under review.

There is little doubt in my mind that these public demonstrations, under impossible or disadvantageous conditions in a busy city where electrical disturbances abound on every side, must be doing serious harm to the new cult, and in the aggregate tend to render broadcasting unpopular. I commented similarly on this rather serious aspect of the subject on the occasion of the public demonstration at the Horticultural Hall, which certainly did broadcasting no good at that time, owing to the enormous amplification and consequent distortion. I have listened-in under all sorts of conditions, and have no hesitation in confirming that, given a high grade and efficient set, coupled with the best loud speaker obtainable, the quality of the reception, subject to certain atmospheric and geographical factors not yet thoroughly understood, is extremely good and capable of affording a vast amount of pleasure and entertainment to its devotees.

A Commendable Wiring Scheme.

The Chesterfield Electricity Committee has approved in principle a scheme for supplying electric light to small houses not already wired for the purpose. The proposal is for the corporation to fit up the house at an estimated cost of £7, the expense of installation and interest to be included in the unit charge for electricity consumed. It is required that the landlord shall make the use of electric light a condition of tenancy, and further, that all gas fittings shall be removed. The installation will eventually become the property of the landlord, and the tenant will be required to pay for repairs. Quite a promising scheme this for getting over the obstacle of initial wiring and fittings outlay, which debars so many would-be consumers among the smaller householders from taking the plunge.

Another point worthy of note in connection with special tariffs is that these alternative schemes for contracting to take a supply are frequently none too well known to consumers, who are thus left in ignorance of the possibilities of effecting economies in their electricity bills. An instance of this is reported in the *Yorkshire Observer*. It seems that a careful and conscientious Leeds ratepayer has just been unloading himself of a quantity of righteous indignation, and has made a discovery thereby which will be of much benefit to him. The ratepayer is a user of electricity, and recently went to pay his bill for the quarter. He had used seventy units, at 3½d., and his bill, including a temporary increase due to inflated prices, came to £1 14s. At the same time he paid a bill for a relative who had used ninety-five units, but whose bill only amounted to 18s. 5½d.

Inquiries revealed an interesting arrangement which does not seem to be generally known in the district. Domestic users of electricity in Leeds may pay an annual charge in quarterly instalments, based on the rateable value of the house, plus a charge of ½d. per unit. In the case of the relative the annual charge was 30s. The quarterly instalment was 7s. 6d., and he got his ninety-five units of electricity for 3s. 11½d. The temporary increase was 7s., and he was 15s. 6½d. and twenty-five units to the good. Needless to add, the first consumer is now also paying on the annual charge basis. The moral of the story is that in the interests of Leeds electricity supply this alternative system and its possible economies should be made better known to the general body of consumers.

ELEKTRON.

A STEADY D.C. FOR TELEPHONY.

At the meeting of the Informal Section of the I.E.E. on Monday, February 5, Mr. F. Pooley was in the chair, when Mr. J. Coxon opened a discussion on "The Supply of Steady D.C. for Telephonic Purposes."

Mr. Coxon's remarks were confined to those telephone exchanges of the 3,000 or so about the U.K. which are large enough to require a special power installation, and may have an equable load through the night to 8 a.m., rising rapidly to a peak load of several hundred amperes about 11 a.m.

He described the ripple obtained with the ordinary D.C. generators of commerce, due, it appears, to the slots of the commutator and the pull of the pole pieces, which makes some other source of supply essential. He spoke of the attempt to obtain a generator which, through a choking coil, would deliver a smooth current, but after a fair measure of success the search seems to have been abandoned.

He then described and criticised the standard double-battery systems, which are extravagant, as one battery is only standing by, while each has a capacity equal to full load for thirty-six hours, and he reviewed the method of overcoming waste of battery capacity by means of a floating battery discharging during heavy hours.

Mr. Coxon exhibited several slides of the homopolar dynamos, and appealed for the interest of designers in special D.C. generators as a practical method of abolishing the batteries. He said the main difficulties of the homopolar machines had been due to the high peripheral velocity required to obtain normal commercial voltages, but with telephone circuits low voltages only are required.

Fourteen speakers joined in the subsequent discussion, and Mr. Coxon, in conclusion, dealt with the points raised.

SECONDARY BATTERIES FOR TELEPHONE EXCHANGES.

The storage batteries form an important part of the plant in a telephone exchange, and in the large exchanges, batteries of some considerable size are employed. It is the usual practice to make provision for the addition of further plates in order that the capacity may be increased as the exchange develops.

The "D.P." Battery Co., Ltd., have in hand at the present time two batteries of 2,818 ampere hour capacity (ultimate capacity, 4,933) for Minories Exchange, London, also four batteries of over 1,000 ampere hour capacity each for Newport, Mon. The "D.P." Battery Co., Ltd., have made a speciality in this work, and have been responsible for battery installations in many of the leading telephone exchanges and wireless stations in the country.

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THE AUTOMATIC DIRECTOR IN STROWGER METROPOLITAN TELEPHONE SYSTEMS.

(*Concluded from page 77.*)

SEARCHING TIME.

The relation between the calling office and the called office is determined by a consideration of the trunk routes. A suitable train of office selectors is provided in each office through which the trunk route passes, so that the call may be set up link by link through intermediate or tandem offices. The various links correspond to different selector levels, so that it is easy to see what impulses must be sent to build up the connection link by link from one office to another, and therefore what the relation must be between the letters corresponding to the office code dialed and the impulses to be sent out by the director.

The plurality of wipers of the director digit switch are brought into circuit successively, and cause series of impulses to be sent out in a certain sequence, as determined by the cross connections of the several bank contacts. A terminal block is provided in the director so these cross connections can be altered with a minimum of effort.

In case only two links are required to reach the terminating office, say, 1-4, the first and second contacts of position 21 would be connected to points 1-4 on the terminal block, and the other contacts of position 21 would be connected to special points on the terminal block and would cause the sender control switch to advance to the position to send the significant digits of the call number.

The director has one hundred sets of bank contacts, and, when used with the non-digit type director-selector, has mechanical facilities for 100 two-letter office designations. When used with the digit type director-selector it has facilities for 1,000 three-letter office designations.

With the types of dial lettering shown in Figs. 1 and 2, it is not possible to use the full 100 two-letter designations or the full 1,000 three-letter designations referred to above, both on account of unpronounceable combinations of letters representing the different numerals and on account of numerical conflict of different office names.

In spite of these limitations, the requirements of even the largest possible metropolitan areas may be easily

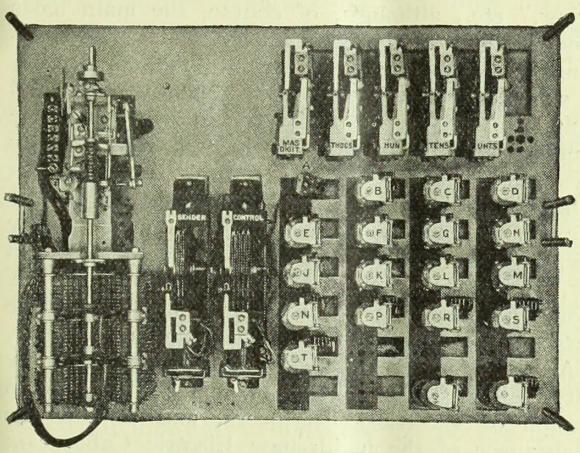


FIG. 4.—DIRECTOR UNIT READY FOR MOUNTING.

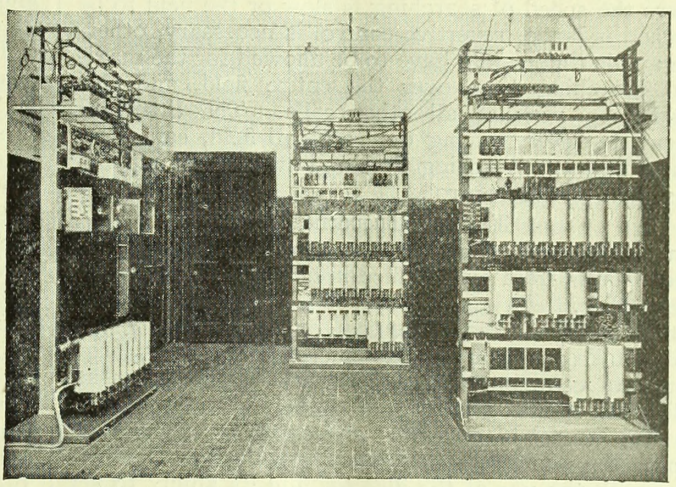


FIG. 5.—AUTOMATIC ELECTRIC COMPANY'S MULTI-OFFICE DEMONSTRATION LABORATORY.

For example, suppose to reach the MAIn office it is necessary to set up four links represented by the respective digits 1473. The four contacts of position 21 in the banks of the director reached from the fifth level of the director-selector would be successively cross connected to points 1-4-7-3 on the terminal block. As soon as the office code has been registered, the sender control co-ordinates the first wiper of the director digit switch with contact 1 in the sender bank, and one impulse is transmitted. The sender control then steps to the next position and co-ordinates the second wiper of the director digit switch with contact 4 in the sender bank, and four impulses are transmitted. The remaining impulses, 7 and 3, are successively transmitted in a similar way. The sender control then advances one point and co-ordinates the contacts of respective numerical digit registers, and sends out corresponding impulses.

taken care of by the use of three-letter office designations.

From the preceding it can be seen that either a two or three digit office code can be arranged to direct calls over one, two, three or four links to reach the terminating office, and it is felt that such provision will be adequate for most cases. By adding another set of wipers and a contact bank to the digit switch in the director, provision can be made for six links.

As soon as the registration of the office code has been completed the director begins sending the series of impulses and if, in the meantime, any of the numerical digits have been registered these will be sent in turn. After the entire call has thus been sent the director is instantly cut out of the circuit and made available for another call.

If when a director has been seized there is a lapse of time greater than some predetermined interval,

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say, thirty seconds, the director is cut out of circuit and made available for another call. Provision can be made so that, in case of an abnormally delayed call, that part of the connection which has already been set up will be released, and the call will be automatically routed to a monitoring operator, after which the director will be released and made available for another call.

The equipment group forming the director is assembled on a demountable base much in the manner of Strowger selector and connector switches. A complete director occupies approximately the space required by four selectors. Each director has its own simple cross connecting block, which has been previously mentioned, thus permitting changes being made in the numbering or routing without interference of service.

Cross Connections.

The director sends the various series of impulses at a predetermined rate and allows ample time between digits for the selectors to search over the maximum of ten trunks. This searching time will not exceed one-third of a second. There is, therefore, no need for revertive control to allow the selector to pick a trunk before the director sends its next series of impulses. Where the speed of searching is slow or the field to be searched is large, revertive control is necessary, otherwise ample time would have to be allowed for the maximum searching time over the entire field, and this would then penalise all other calls. The Strowger system, however, having only a small field, can allow a short uniform searching time and avoid the complications of revertive control.

Tandem Trunking.

In large metropolitan areas it is not efficient to have direct trunks from every office in the network to every other office. In manual practice tandem trunking switchboards, located at certain trunking centres, are used to take advantage of the efficiency offered by large groups of common trunks, but since this requires an additional operator at the tandem point there is an increase in cost of operation and a greater chance for errors; the plan, therefore, has its limitations. However, with the use of the director and its ability to set up any required number of links to reach the terminating office, it is possible to use the tandem trunking principle to its utmost, being governed entirely by considerations of plant economies, without regard to traffic and operating complications that would have to be considered under manual conditions. On account of the cross connecting facilities in the director, tandem trunking can be arranged at any time and changed from time to time as required.

Finance.—The directors of the Yorkshire Electric Power Co., Ltd., have issued an excellent report for the year 1922. The net profit, including balance brought forward, is nearly £125,000, and after paying the 6 per cent. dividend on the cumulative preference shares it is proposed to pay 8 per cent. on the ordinary, to add £25,000 to the general reserve fund, and carry forward nearly £27,000.

The I.E.E.—The following are the arrangements of the Students' Section, South Midland Centre, for the second half of session, 1922-23:—February 16, F. R. Coombes, "Protection"; February 27, smoking concert, to be held at the Queen's Hotel, Birmingham; March 9, radio demonstration and discussion; March 23, F. Adcock, Ph.D., and E. H. Wells, Ph.D., "Temperature Measurements with the Einthoven Galvanometer"; April 27, annual general meeting, to be followed by F. H. Beacon, "Mining Switchgear."

Reviews of Books, &c.

[Books noticed in this column will be sent from ELECTRICITY *Office to any part of the world, for the published price, plus ten per cent. for postage (minimum 2d.) and orders will be appreciated.]*

Handbook for Electrical Engineers. By Pender. Second edition, f'cap. 8vo, cl., 2,263 pp., profusely illustrated. (Chapman and Hall, 30s. net.)—This is one of those monumental handbooks which give in a condensed but at the same time eminently clear and practical form an epitome of present-day electrical science as utilised by engineers the world over. Not only so, but it contains chapters on subjects which are certainly not electrical, although they show what can be done by mechanical power, and, therefore, are of use to those who may have to prepare electrical schemes in competition with such power. For instance, "Locomotives, Steam," deals only with the steam locomotive as distinct from "Locomotives, Electric," and is quite an instructive and valuable résumé of the leading types, their classification, design, tractive effort, fuel and water consumption, annual costs, etc. So, also, with the chapters on "Heat and Steam Engineering," "Engineering Materials," "Structural Engineering," "Hydraulic Engineering," etc., although, of course, the main basis and, indeed, bulk of the book is electrical. The chapters themselves are arranged in the alphabetical order of the subjects treated upon, from "Abbreviations and Symbols," to "X-Rays," and have in every instance been most carefully revised or, indeed, rewritten by the responsible experts, while entirely new articles have been added on such important subjects as the electric propulsion of ships, electric welding, frequency changers, phase converters, etc., etc. Mr. Harold Pender, the editor-in-chief, is well known as the director of the electrical engineering department of the University of Pennsylvania in Philadelphia, and Mr. Wm. A. Del Mar, the associate editor-in-chief, is an old City Guilds' student, an assoc. member of our own Institution of Electrical Engineers, and is now the chief engineer of the Habirshaw Electric Cable Co., Yonkers, New York. Yet another well-known name is Mr. H. M. Hobart, M.I.E.E., who has contributed to various sections, and "Telegraphy and Telephony" has been revised by Mr. S. G. McMeen, the great authority on the latest advances in those branches of electrical engineering. Each chapter finishes with a useful bibliography of the best treatises on the subject dealt with in the text, and there is not the slightest doubt that this new edition will have a hearty welcome from enterprising electrical engineers wherever the English language is spoken or read.

Lockwood's Builder's and Contractor's Price Book, 1923. (Lockwood, 7s. 6d. net.)—The new edition of our old friend does not call for much comment. Mr. J. P. Allen, the editor-in-chief, always does his best to maintain the high reputation which the book holds in the building trade, and he has made all such alterations and revisions as are possible and suitable, considering that costs of labour and materials are not by any means stabilised. The electrical sec-

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tion, which is contributed by Mr. A. P. Haslam, M.I.E.E., is one of the largest and best in the whole book and bears evidence of very careful thought and preparation. He covers the ground fairly thoroughly, but we would suggest that when preparing the next issue reference should be made to some of the many patent wiring systems now on the market. They are helping to reduce installation costs very materially. The book should undoubtedly find a place in the office of every electrical contractor.

ADVERTISING AND SELLING ELECTRICITY.

Mr. J. W. Beauchamp, M.I.E.E., gave a lecture on Saturday, February 10, at the Birmingham and District Electric Club on advertising and selling in relation to the electrical industry. In an exceedingly interesting address he explained the objects of "The Electrical Development Association," and emphasised the importance of co-operation among supply authorities, manufacturers and contractors in arousing a national interest in the use of electricity, and thus preparing the ground for more detailed individual selling efforts. He showed that the work of the association was to make new consumers, and to stimulate the demand for new apparatus, and not to divert orders from one manufacturer to another. The work was of the more importance to counteract the very intensive work of the British Commercial Gas Association.

The E.D.A. was established by various electrical bodies to provide a means for this particular co-operative work, and Mr. Beauchamp gave details of the methods and procedure of the Association, including Press advertising exhibitions, posters, the issue of booklets, leaflets and the like; the preparation of matter for the publicity campaigns of supply authorities and contractors; the investigation and preparation of data useful to salesmen; and the organisation of sales conferences. The latter is at the moment the most important phase of the association's activities, it being a regrettable fact that the arousing of the electrical industry to a realisation of the importance of modern selling methods was a very necessary and difficult job.

Mr. Beauchamp hoped that the Birmingham and District Electric Club would assist in organising one of these conferences in Birmingham in the near future.

M.-V. SHOWROOMS.

The Metropolitan-Vickers Electrical Co., Ltd., have now opened new showrooms at their Manchester address, No. 14, Long Millgate. These are appropriately decorated for the display of electric light fittings in true period designs. This makes the choice of the right fitting a much easier matter than when it is merely taken from its wrappings and set on a warehouse counter. The fittings are made by Messrs. Harcourts, Ltd., of Birmingham (recently acquired by Metropolitan-Vickers Company), who have a reputation as ornamental brass founders extending back for 100 years. Fittings of a plainer type are also on view, and there is a special room of particular interest to the trade where wiring materials and supplies are installed. There is also an electric kitchen, in which cooking demonstrations are given by means of the well-known "Cosmos" utensils.

The "Cosmos" Radiophone in various types and sizes is also part of the showroom display, and visitors can listen to broadcast entertainment.

The M.-V. Company, recognising that it is difficult for the electrical contractor to supply adequate showroom accommodation for the display of high-class fittings, and for demonstrations of electric cookery, have opened showrooms in London, Birmingham, Bristol, Cardiff, Edinburgh, Newcastle-on-Tyne, Leeds, Sheffield and Manchester, with a view to helping to fill this need and in the hope that the electrical contractors near these centres will make use of them by sending their customers to see these displays and demonstrations. Full credit, we understand, will be given for any business done in this way.

STEAM TURBINES.

The question of steam turbine design, as previously dealt with by Metropolitan-Vickers Electrical Co., Ltd. (Trafford Park, Manchester), in their Circular No. 1435/2a, is now more fully dealt with in their Special Publication No. 7445/2, which runs to 88 pp. (11 in. by 8½ in.), and is very finely produced. The turbine plant manufactured by the M.-V. Company is of the Rateau-Impulse type, and, after some introductory remarks explaining, with diagrams, the general arrangement, the subject is treated in a practical straightforward manner down to the smallest detail. There are 58 illustrations in all, many being sectional diagrams and others made from photographs of complete machines or component parts. The subject matter is divided into seven parts:—(1) Introductory; (2) H.P. Turbines; (3) Recent Developments in Large Turbine Practice; (4) Feed Heating Systems for H.P. Turbines; (5) Reducing and Back Pressure Turbines; (6) Mixed Pressure Turbines; (7) Geared Turbines. There is a most imposing (subdivided) list of M.-V. turbines installed and on order.

COMFORT ON LONDON'S UNDERGROUND.

Experiments have been in progress for a long time to determine the best all-round design for the rolling stock on the underground railways of London. It was determined that the most efficient way to arrange the doors is for there to be a pair of double doors on each side of the car. To provide as silent running a car as possible experiments were carried out by Dr. A. M. Low to locate the principal causes of noise—by photographic records of the various sounds produced. As a result it has been determined that in future the car bodies are to be of metal, and certain general principles as regards ventilation and the exterior design have been determined. In order to determine further the most convenient interior design the company have designed an experimental car, and have obtained from each of five of the leading rolling-stock manufacturers in this country an experimental car of the firm's own design. These six cars are now undergoing severe tests, and are about to be put into service so that the public will be able to aid the company in picking out the best features of each, with the object of obtaining a quiet-running, comfortable, well-lighted standard

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design for future use. The first order to this standard design will be for cars required on the Hampstead and City and South London lines between Hendon (Central) and Highgate and Moorgate; which is scheduled to be opened for traffic in October next.

Various Items.

Swansea.—The recent electrical exhibition cost the Corporation £442, the expenditure being £1,218 and the revenue £777. The total attendance was 35,702.

Ballybay (Ireland).—The T.C. have decided to form an electric light company for the town, the company to be managed by the Town Council in the interests of the ratepayers.

China.—Tenders are invited for the supply of electric railway signalling material for the Peking-Mukden Railway. Specifications and particulars from Mr. C. P. Sandberg, 40, Grosvenor Gardens, London, S.W. 1.

Unemployment.—In the February issue of *Production and Export*, the journal of the British Empire Producers' Organisation, there is an article of particular interest by the chairman of the organisation, Mr. Ben H. Morgan, entitled "Permanent Cure for Unemployment."

Two New Diesel Electric Ships.—According to the current issue of *The Motor Ship*, the Great Lakes Engineering Works, Detroit, have received an order from the McDougall Terminal Warehouse Co., Duluth, Minnesota, for two Diesel electric ships each of 258 ft. in length.

Meetings.—An extra meeting of the I.E.E. will be held on Thursday, 22nd inst., at 6 p.m., when Dr. H. W. Nichols will deliver a lecture on "Transoceanic Wireless Telephony," to be followed by a discussion. Also Mr. B. Welbourn will exhibit two cinematograph films on "The Electrification of the Chicago, Milwaukee and St. Paul Railroad Company."

Obituary.—Another well-known veteran in the electrical industry has just recently passed away in the person of Mr. F. Sales Thomas, the managing director of the Saxonia Electric Wire Co., Ltd. In his early days Mr. Thomas was connected with the Bessbrook and Newry Electric Tramway, and a wide circle of friends will mourn his loss. He was about 65 years of age.

"**The Wireless Dealer.**"—This is the title of a new wireless paper to be published monthly, of which the first number will be ready in March. It is published for the trade only, and will, of course, appeal directly to the actual dealers in wireless apparatus and equipment. Full particulars may be obtained from the Trader Publishing Co., Ltd., 139, Fleet Street, London, E.C. 4.

A Patriotic Resolution.—At a meeting of the Council of the I.E.E., held on the 1st inst., the following resolution was passed:—"That in view of the present state of trade and employment, the Council request members who place, or who advise upon the placing of orders, to specify, as far as practicable, that the plant and material ordered shall be of British manufacture."

Joint Lecture.—A joint lecture, entitled "Preparation of Estimates, Specifications and Contracts for Electrical Work," will be given by Messrs. W. E. Highfield and Alan Kirk, of the N.A.S.E., and Captain A. E. Penn, of the Engineers-in-Charge, at St. Bride's Institute, on Tuesday, 27th inst., at 7 p.m. It is certain to be of direct interest and value to a large number of members of both Institutions.

Wireless Enthusiasm.—The inaugural meeting of the St. Bride Radio and Experimental Society will be held in the large hall of the St. Bride Foundation Institute on Wednesday, 21st inst., at 7.30, when the President, Capt. H. Riall Sankey, C.B., has kindly consented to open the proceedings with a short address, to be followed by a demonstration and general meeting. Visitors are cordially invited to attend and take part in the proceedings.

Finance.—The directors of W. T. Henley's Telegraph Works Co. have decided to recommend a final dividend on the ordinary shares of 2s. per share, less income tax, making, with the interim dividend of 1s. per share paid on September 1, 1922, 3s. per share for the year.——The directors of the Charing Cross, etc., E.S. Co., Ltd., recommend a dividend on the ordinary share capital of the West End undertakings of the company for the half-year ended December 31, 1922, making, with the interim dividend already distributed, 12 per cent. for the year 1922, and a bonus of 2s. per share (free of tax).

Siam.—During 1921-22 electrical goods and apparatus to the value of £138,000 were imported into the country, as compared with £112,000 in 1920-21.

The Electrical Contractors' Assocn.—On January 31 a sub-branch of this Assocn. was formed at Croydon, comprising the electrical contractors in the Croydon area. Mr. A. D. Dean was elected chairman, and his son, Mr. J. A. Dean, hon. sec. Meetings are to be held on the last Wednesday in every month.

Practical Education.—A Conference on "Practical Education" will be held at Cheltenham at Easter, and a well-known firm of electrical engineers are equipping and demonstrating a wireless installation for the benefit of the members of the National Association of Manual Training Teachers, by whom the Conference is being held.

Argentina.—The D.O.T., 35, Old Queen Street, London, S.W. 1, has received a telegram from Buenos Aires to the effect that the Department of Sanitary Works are inviting tenders for 19 groups of vertical centrifugal pumps with electric motors and spare parts. This advance information may enable English makers to communicate with their representative in the Argentine with regard to the matter.

Broadcasting in Cardiff.—The Broadcasting Station in Cardiff having now commenced operations, Messrs. Siemens Bros. and Co., Ltd., have made arrangements to give demonstrations of their Broadcasting receiving apparatus at their branch office in St. Mary Street, Cardiff (telephone No. 1960). Electrical dealers in South Wales are therefore cordially invited to make an appointment by communicating with the company's branch office.

Benevolence.—We have received from Mr. F. B. O. Hawes, the secretary of the Electrical Trades' Benevolent Institution, a printed list of the contributions given in connection with the recent annual festival dinner, the total amounting to £852 9s. 3d. What is wanted is some benevolent-minded individual to send along a cheque to make up the level £1,000. We are certain that Mr. Hawes would give it a very hearty welcome.

A Handsome Souvenir.—We have to thank the Relay Automatic Telephone Co., Ltd., of Marconi House, Strand, W.C. 2, for a handsome souvenir of the Relay Automatic Public Telephone Exchange, which was supplied by the company to the British Post Office for the public service in Fleetwood. It contains a fully illustrated description of the whole installation, details of which were given in our issues of November 24, December 1 and 8 last year.

Faraday House.—The Lent term issue of the *Faraday House Journal* is, as usual, full of interesting information in regard to the institution itself and the progress which is being made by the present-day students, as well as of the men who have gone through this great institution in the past, and are now holding high positions in all parts of the world. Mr. T. R. Warren contributes an instructive article on "The Insulation Resistance of Three-phase Networks," and there is also a well-written account of the Hebburn Works of Messrs. Reyrolle and Co., Ltd., together with a brief report of the annual dinner of the old students.

Obituary.—It is with regret that we announce the death of Mr. Percival Philip Kipping, which took place on Sunday, February 4, at his house at Harrow. Mr. Kipping was 57 years of age, and had always been actively associated with the science of telephony. At an early stage in his career he was the proprietor of the Universal Telephone Company, which was afterwards merged into the National Telephone Company, of which concern he became traffic superintendent. Later he was employed in Glasgow and afterwards joined the General Electric Co., Ltd., as manager of the telephone department. On the formation of the Peel Conner Telephone Works (proprietors, the G.E.C., Ltd.), he became the secretary of this concern and was also technical director of the Bogota Telephone Co. Mr. Kipping was a prominent Freemason, of whom many were present at the graveside, and was highly respected among his colleagues in the G.E.C., and indeed the whole of the electrical trade.



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A POPULAR SCIENTIFIC WEEKLY JOURNAL
ELECTRICITY
A PRACTICAL TRADE JOURNAL

FEBRUARY 23, 1923.

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THE ELECTRIFICATION OF A RAILWAY CARRIAGE AND WAGON WORKS.

One of the largest industrial undertakings in Leicestershire is the Railway Carriage and Wagon Works at Coalville, the proprietors of which are Messrs. Stableford and Co., Ltd. (managing director, E. P. Booth, Esq.).

This company started with a few small shops over 50 years ago, and having steadily increased its activities, now has works covering over 30 acres. The shops comprise forges, smithy, machine, erecting (capable of accommodating 200 wagons, and served with a modern compressed air system), stamping and hydrauiic pressing, saw mills, wood wagon, punching, and shearing, tool, heat treatment and oxy-acetylene welding, foundry, pattern, as well as an experimental laboratory.

The whole of the works was recently electrified throughout, the contractors being the General Electric Co., Ltd. The power house is centrally situated, the principle generating unit being a 1,250 K.V.A. G.E.C.-Fraser and Chalmers turbo-alternator. The turbine is a high pressure machine running at 3,000 r.p.m. and capable of developing an automatic overload of 25 per cent. The steam conditions are as follows :—

Pressure ..... 200 lb. per square inch.
Super heat .... 500 degrees, total temperature.
Vacuum ..... 28 inches with barometer at 30 in.

The alternator is a 3-phase 50 cycle machine wound for 440 volts. It has a solid rotor, special clamping system for supporting the end windings of the stator, a ventilation system which keeps the air for cooling the rotor entirely separate from that which cools the stator; this air being passed through a Sturtevant air filter.

The condensing plant consists of a surface condenser supplied by Worthington-Simpson, and cooling is effected by a chimney cooling tower supplied by the Premier Cooler and Engineering Co., Ltd., with a capacity of 85,000 galls. per hour. The pumps are driven by a 50 h.p. motor in a roomy basement below the power station floor.

In addition there is a 125 K.V.A. alternator, driven by a Bellis steam reciprocating engine. This is intended for nightshift or week-end purposes. The switchboard is arranged on a gallery sufficiently raised for the attendant to command an uninterrupted view of the station.

The power house is served by a 12-ton hand-operated Morris crane, and sufficient space is provided for the duplication of the present plant.

The boiler house contains two Adamson Lancashire boilers with space for a third, 30 ft. by 8 ft., with Green's economiser and Adamson superheaters. Induced draught is supplied on the Louis Prat system; feed is effected by two Clarke Chapman pumps.

Sub-stations are suitably situated in the works.

As far as possible a standard size of motor was adopted for the various machine tool drives, and about two dozen 3-phase "Witton" squirrel cage motors

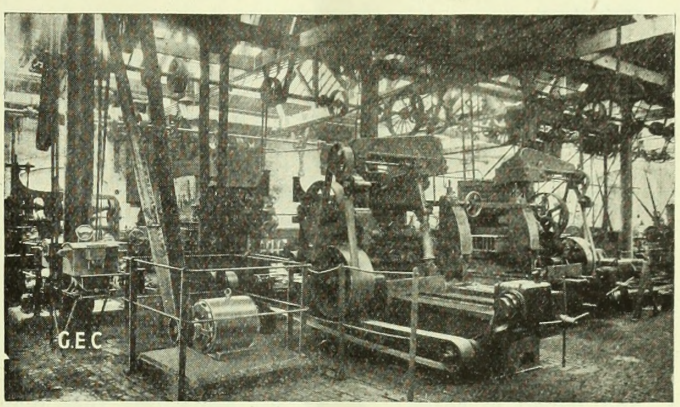


FIG. 1.—GIRDER MILLING MACHINE, BELT DRIVEN BY 25 H.P. "WITTON" 3-PHASE MOTOR.

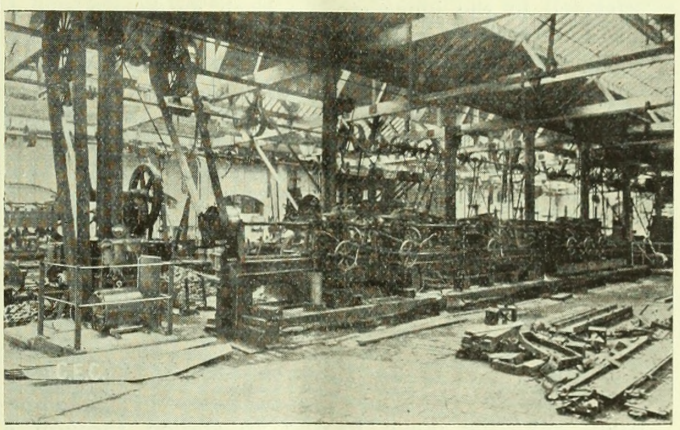


FIG. 2.—MULTIPLE DRILLING MACHINES, BELT DRIVEN BY 25 H.P. "WITTON" 3-PHASE MOTOR.

have been installed, the majority of the drives being through belts. The motor speed is 960 r.p.m. Naturally, it was not possible to meet quite all the requirements for driving with one size of motor, and in consequence a few other sizes are to be found, such as the 60 h.p. machine driving shafting in the stamp shop. Typical examples of the drives of the 25 h.p. motors are seen in Figs. 1 and 2; in each case the

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G.E.C. auto-transformer starter is seen in proximity to the motor.

In addition the G.E.C. were entrusted with the design of the electric lighting installation. In most instances direct overhead lighting by steel reflector fittings was specified, but in many shops semi-indirect industrial pendants were used. All the lighting points are equipped with Osram lamps, those in the larger shops being of the gasfilled type.

TELEGRAPHY.*

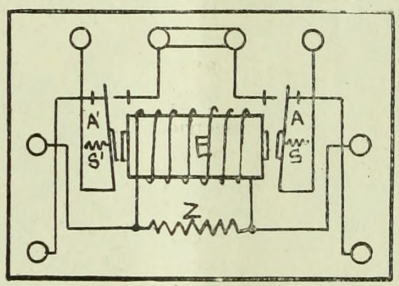
Being Solutions to the Questions set by the City and Guilds of London Institute at the Final Grade Examination in Telegraphy held in May, 1922.

COMPILED BY A SILVER MEDALLIST.

Q. 1.—Describe with the aid of sketches the construction and action of the automatic switch used on repeaters.

A.—Fig. 1 shows the principle of an automatic switch, together with its internal connections. *E* is an electromagnet consisting of two coils placed abreast

FIG. 1.



and joined in series. *A*, A^1 are armatures that play between the contact points shown, being held normally against the outer stops by means of spiral springs *S*, S^1. When a current of certain strength passes through the coils in either direction the armatures are attracted to the inner stops. Each automatic switch on a repeater corresponds to one of the terminal stations, and its function is to respond automatically to the movements of the key switch of that particular station. If the key switch at a terminal station is put to the "send" position the armatures of the corresponding automatic switch are attracted; if it is put to the "receive" position, the armatures are pulled by springs to the outer stops. In the first case the result is to connect the section of the line leading to the distant station to the repeater battery, while in the second case the line to the distant station is joined to the repeating instruments but disconnected from the repeater battery.

The operation of the automatic switch will be best understood by following the operation of signalling from, say, the down to the up station through a repeater. Fig. 2 shows the general arrangement, in skeleton form, of a double current simplex repeater on which automatic switches are used. Suppose the down station key switch is put to "send," a current will flow over the line from the down to the repeater office and will pass through the down-side galvanometer, the right-hand armature of the automatic switch *V*, polarised relays *R* and *P* to earth. The tongues of the relays *R* and *P* are therefore placed on their spacing contacts. The operation of relay *P*, which is a polarised neutral relay having its tongue fitted with adjustable springs for holding it normally midway between the contact stops and clear of both,

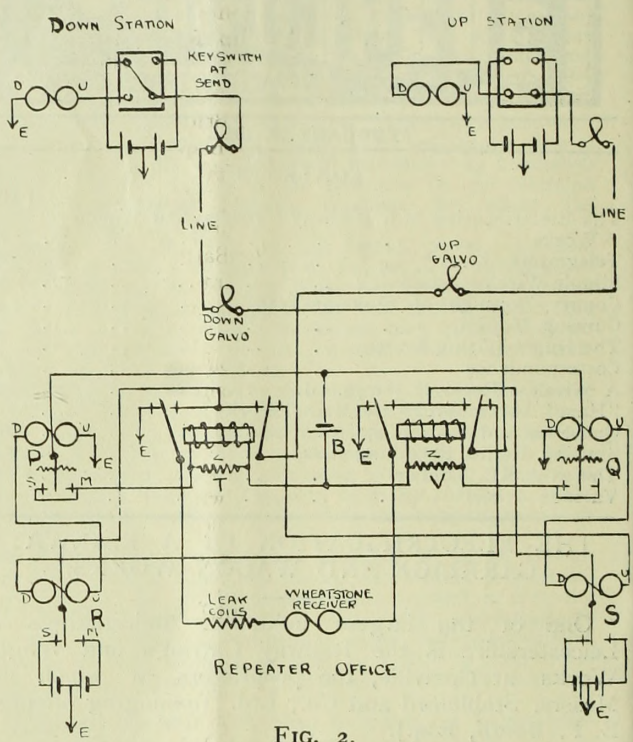


FIG. 2.

completes the circuit of a local battery *B* through the automatic switch *T*, and the latter is energised, thereby attracting its armatures to the inner stops. This connects the tongue of the transmitting relay *R*, via the right-hand armature of the automatic switch *T* to the line leading to the up station, and a spacing current is sent to the latter because the tongue of relay *R* is on the spacing contact. If the down station key is depressed the line current is reversed in direction and the tongues of both relays *R* and *P* are attracted to their marking stops, and a marking current is sent to the up station.

During the operation of signalling from the down station the tongues of the relays *P* and *R* vibrate in unison with the signals passing through. The circuit through the automatic switch *T* is therefore being continually broken and closed again, and in order to prevent the armatures from breaking contact during the passage of the tongue of relays *P* from one stop to the other the coils of the automatic switch are shunted by a resistance *Z* of the same value as the coils *E* themselves, viz., 1,000 ohms. This makes the automatic switch sluggish in its action by providing an easy path for the self-induced currents in the coils when the momentary breaks occur in the local circuit, and consequently preventing the demagnetisation of the cores.

A leak circuit is connected to the automatic switches, as shown, in order to enable the repeater clerk to check the working of the repeater.

When the down station has finished sending, the key switch there is put to "receive" and the line current is thereby cut off. The armatures of automatic switch *T* are then pulled back by the springs and the apparatus is ready for the up station to send.

(To be continued.)

* Consult also "Questions and Solutions in Telegraphy and Telephony," Final Grade, by Few, 2s. 3d. post free from ELECTRICITY Office.

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SIMPLE WIRELESS RECEIVING.

The following is a condensed report of the proceedings on the informal talk on "Simple Wireless Receiving," given by Mr. Philip R. Coursey, B.Sc. (Eng.), A.M.I.E.E., F.Inst.P., on Wednesday, January 31, 1923, under the auspices of the Association of Engineers-in-Charge at St. Bride's Institute, the chairman being Wm. McLaren, Esq. The time fixed for this event was 7.30 p.m., in the Board Room, but long before this hour the seating accommodation had been exhausted, and members and friends still continued to arrive—fortunately the Bath Hall had become vacant, and it was voted to transfer the meeting thereto, where ample room was available for everyone. This at once showed the intense interest any discussion on wireless could arouse. The chairman, after introducing the lecturer, said that he felt sure all were as keen as himself to be dispelled by Mr. Coursey of the "mystery" of wireless transmission; and as events proved, to a very great extent this was characteristically dealt with in all its points by the very clear lecture that followed.

Mr. Coursey aptly remarked that nearly all power stations were transmitting agents, inasmuch that every time a circuit breaker "came out," or the brushes of the machines "sparked," impulses in a small way were caused to the ether, in the same way that in commercial wireless stations it was done by high tension generators. Many types of rectifying minerals were mentioned by the lecturer, included galena, bornite, zincite, carborundum and silicon, etc., but owing to the more recent introduction of the thermionic, or three-electrode, valve, to a great extent crystals were not now so largely used, owing to their limits of reception of signals (telephony about 15 miles, and telegraphy about 150 miles). A brief description of the working of a valve was given, and its various parts mentioned, viz., the filament, grid and plate. A method of collecting the minute high-frequency and extremely high-periodicity currents was by erecting an aerial conducting wire on insulators, and connecting this to the wireless instrument, and another wire to be connected to a water pipe, and so causing a "loop" conductor. Another new feature of receiving broadcast telephony was mentioned in the piece of apparatus known as the "Ducon" condenser, for fixing to your existing electric lamp-holder and so utilising the wiring of the house as an indoor aerial. The lecturer gave a few details relating to the method of obtaining licences for radio telephony, and also explained the meaning of the now familiar sign on wireless instruments, B.B.C. (British Broadcasting Company), this sign only appearing on sets approved by the G.P.O. for use on broadcasting. Experimental licences were also dealt with, and it was pointed out that where the applicant could prove to the G.P.O. that there was a valid reason for seriously wishing to experiment in radio research, invariably such licences were granted. The lecturer concluded by saying that he hoped, in the short space of time available, he had to some extent helped to lift some of the "haze" from the members on the question of radio telephony, and invited any member for questions on the matter.

This remark at once made many members rise simultaneously, all endeavouring to catch the speaker's eye, and anxious for more knowledge on the subject, asking such questions as:—Whether receiving sets would be affected by local power stations? Cause of oscillation? Is it better to have high-frequency detectors or low frequency? Why did a certain set (home made) work minus the "earth" wire attached? Who discovered the rectifying properties of crystals? Why was it necessary to have a "grid leak" in a valve set? Would a single aerial wire be more efficient than a twin, etc., etc.? All were dealt with at great length and patience by Mr. Coursey, and it was evident that, having quite aroused the "spirit of radio" in the members, it would be at no very distant date that a further informal talk on this matter would take place. The time was getting very late, and it was with regret that the meeting had to close after a most hearty vote of thanks had been given to the lecturer by Mr. Wm. McLaren, and seconded by Mr. Watkins.

H. M.

COUNTY BOROUGH OF STOKE-ON-TRENT.

SUB-WORKS EXTENSIONS.

Public supply of electrical energy in the Potteries was inaugurated by the starting of the Hanley electricity works in 1894. At the Federation of the Potteries in 1910 it was naturally decided to work the whole district as one electrical unit. The principal power house remained at Hanley, supply being given to the "sub-works" at Burslem, Longton and Stoke. The new power house is adjacent to the original one at Hanley (2,200 volts, 100 cycles, single-phase), and supplies electrical energy at 6,600 volts, 50 cycles, three-phase to the sub-works, where it is converted to low tension A.C. or D.C., depending on the system previously in vogue in the different districts. The old plant at the sub-works has been shut down and, except for relatively small but modern turbo-plant to take care of peak loads, the sub-works are now converting stations, *e.g.*, at Burslem in the year 1910-11 the peak load was 746 kw., and the units generated 2,141,387, while in 1921-22 the peak load was 1,027 kw. and the units generated 96,895.

On March 30, 1922, the extensions to the central power house were officially opened, and on January 18, 1923, extensions to the sub-works were officially opened. These extensions comprise the following:—1,000 kw. rotary converter (Metropolitan-Vickers Electrical Co., Ltd.) and 1,000 kw. turbo-alternator at Burslem, the latter machine being by the English Electric Co., Ltd., who also supplied the 600 kw. motor-alternator required at Hanley sub-works, and the 1,000 kw. turbo-alternator for Stoke, where has also been installed a 1,000 kw. motor converter (Bruce, Peebles and Co., Ltd.). The necessary E.H.T. circuit breakers and control panels, and the L.T. switchgear and instrument for Burslem, Hanley and Stoke were supplied by the Metropolitan-Vickers Electrical Co., Ltd. They conform in general appearance to the pre-existing control panels so that a good appearance has been maintained. For the extensions to E.H.T. and L.T. mains, Callender's Cable and Construction Co.,

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Ltd., were responsible. The following notes augment some of the foregoing information.

At Hanley the three-phase switchgear was installed in an existing cubicle in the central power house and is practically similar to that existing. The single-phase switchgear is, in this case, installed in the old Hanley station, and an existing single-phase equipment was modified so as to be suitable for the new machine. The motor circuit is fitted with the Merz-Price circulating current system of protection.

Besides the turbo-alternator and converting plant several new 6,600-volt feeders have been added at Burslem to meet the demand from consumers requiring a bulk supply at this voltage. Consequently the 6,600-volt switchgear has been greatly extended and changes have been made to the existing switchgear to meet the new conditions. A set of moulded stone cubicles equipped with the latest design of oil-circuit breakers has been built for the new circuits. These cubicles are fitted with duplicate busbars to provide a flexible switching system. The existing cubicles were modified to accommodate the duplicate busbar arrangement and these line up with the new set.

The additional control panels have been arranged to be similar in appearance to the original panels, so that a uniform appearance is given to the control board. Special protective devices have been fitted on new circuits to ensure continuity of supply on the rest of the system should a feeder or machine circuit become faulty. These devices are briefly described later.

A similar series of extensions to those at Burslem have been carried out at Stoke. In this sub-station, however, the switchgear changes were more drastic. It was found necessary to pull down and rebuild the existing cubicles in a different position to obtain the space required for the new switchgear. Advantage was taken of this necessity to build all the cubicles required to the same design and at the same time. The change-over and rebuilding of the existing circuits were completed without any interruption of the supply. The cubicles are constructed of moulded stone which is carried in a wrought-iron framework. Duplicate busbars are provided, and the oil circuit breakers are of modern design having a large arc-rupturing capacity.

The control panels line up with those existing and form an extension to this board. Special large synchronising instruments, visible from any part of the control board, have been installed to facilitate the synchronising operation. As at Burslem, special protective devices have been installed on the generator and feeder circuits.

The extensions at Longton have not been so extensive as those outlined above. Two additional rotary converters have been installed and the necessary switch cubicles and panels have been arranged to form extensions to the existing structures. They are similar in arrangement to the existing equipments, but a modern type of circuit breaker has been supplied.

During the past few years, supply in bulk at 6,600 volts has been required by various large firms and surrounding districts. Most of these consumers are supplied from the central power house, but a few are supplied from the 6,600-volt bars in the main sub-stations. These consumers' sub-stations have been supplied with switchgear designed to secure the safety of the operator, as it is likely that the majority will be operated by semi or unskilled men. Most of these switchboards are truck type switchboards fitted with hand-operated circuit breakers. All the apparatus requiring attention is mounted on a movable truck which can be wheeled away so that the adjustments can be made with ease and in safety. When the truck is in position all "live" parts are enclosed, and interlocks prevent the circuit being made or broken on the plug contents.

Devices to limit the area of disturbance in the case of machine or feeder breakdowns have been installed on new circuits and on some of those existing. The circulating current protective system used on generators and converters protects the machine and disconnects from the bars in case of an internal fault. When used in conjunction with an automatic field switch, its instantaneous operation prevents much damage to the machine. It has been found, in cases of machines protected by this system, that repairs required have been very small and the machine has only been out of commission for a very short period.

Two protective systems have been fitted to the main feeders, *viz.*, the Merz-Price balanced voltage system and the split-conductor system. The former is in many respects similar to that above, but the connections are made in a different manner. The principle is the same in both cases, *i.e.*, that under healthy conditions the currents flowing into and out of a circuit are the same, and can therefore be balanced against each other. Any difference between the two due to an intermediate fault can be made to operate a relay and disconnect the faulty circuit from the network.

The split-conductor system utilises the balancing principle in a different manner. The main conductor is divided equally, so that the main current in each portion of the conductor is the same. The two half-currents are then balanced against each other. This system is more sensitive than the balanced voltage arrangements, avoids the use of a pilot cable, but requires a special form of main cable and circuit breaker. Both systems are unaffected by faults or overloads outside the protected area. Therefore, in order to prevent damage by heavy currents when a fault occurs just outside this area, say, on the sub-station busbars, all feeders are fitted with overload inverse time limit relays of the induction pattern. Both the time and overload settings are adjustable, and they are designed so that the more the overload exceeds the relay setting, the shorter is the time of operation of the relay.

Great credit is due to Mr. C. H. Yeaman (Borough Electrical Engineer) and the Electricity Supply Committee for the way they have tackled the difficulties of co-ordinating supplies in different areas at different voltages in a reliable and economical manner.

Bravo, "Gecophone."—The *Belfast Telegraph* reports that on Christmas morning between one and two o'clock Christmas carols and a sermon broadcast from Newark, New Jersey, U.S.A., were picked up in Belfast by Mr. J. D. Morrison, of the G.E. Co., who was listening-in on a standard "Gecophone" two-valve listening-in set. An independent check was taken by Mr. A. Coates, who was able to confirm the result. On the previous night Mr. Morrison heard vocal and orchestral music from the same station, and when it is remembered the "Gecophone" two-valve set is primarily designed for the reception of broadcast telephony from the British Broadcasting Stations, it will be realised that the results obtained on this occasion speak volumes for the design and sensitiveness of these instruments.

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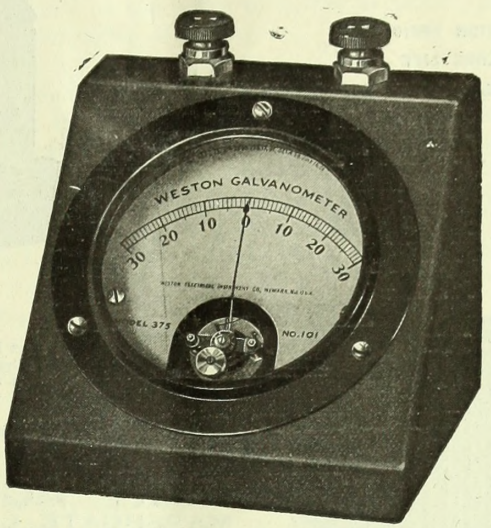
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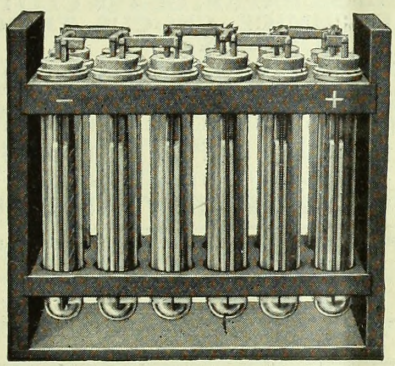


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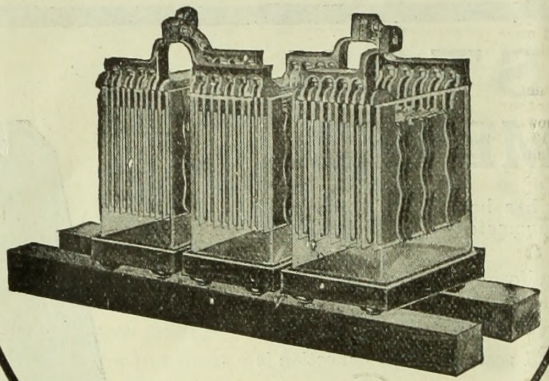
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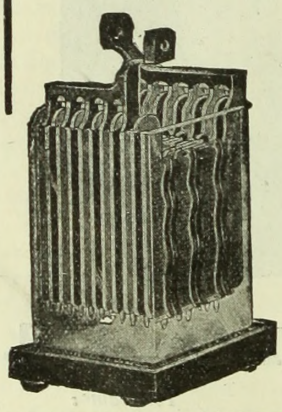
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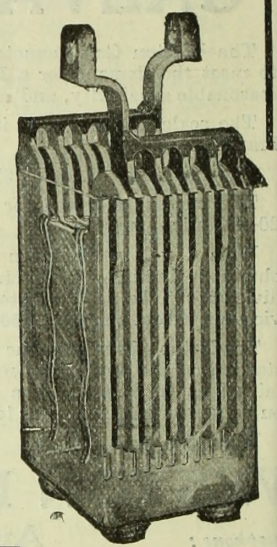
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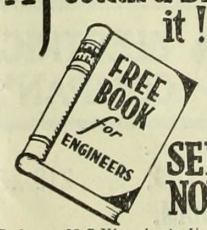
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Current Topics.

Electricity Breakdowns.

Apropos the alarming frequency of supply failures to which I referred a fortnight since, I cordially welcome Mr. J. F. Heslop's letter giving interesting data concerning the Barrow mishap, which, it will be recalled, owed its origin to a mouse, which obtained access to the E.H.T. machine panel controlling a 1,000 kw. rotary converter, through a slot in the concrete slab, provided for the accommodation of the switch connecting rod. As Mr. Heslop infers, this accident serves to direct attention to a defect in the design of this gear, and the very thorough investigation into the cause of the breakdown, indicated by his interesting letter, is just what is needed in every one of these cases to provide the necessary remedy against a repetition. No doubt the Barrow switchgear will now be suitably modified to guard against a recurrence of this incident.

Since I recorded my last somewhat lengthy list of failures in supply there have been several additional breakdowns, all more or less serious. One, at Ilkeston, was due to a shift engineer becoming entangled in the plant at the power station. Fortunately for the man he was not seriously injured, but the electric light supply was interrupted for over half an hour, and the tramway service for an even longer period. Rochdale, also, was plunged in darkness for a few minutes recently by the act of a Radcliffe youth, who threw a steel ring on to a bare overhead transmission line, thus setting up a short circuit on the power line from the Radcliffe Works of the Lancashire Electric Power Company. As in the case of Ilkeston, the tramways were also held up similarly, though only for a brief period. Again, at a West Ham church, the electric light failed during service, and, curiously enough, the hymn immediately following the incident, was "O, Grant Us Light."

By far the most serious failure, however, was at Oldham, where the bursting of a 6,000 kw. turbo-generator at the Corporation Electricity Works interrupted the entire town's supply, and partly wrecked the power-station building and roof. Fortunately there was no loss of life, although two men were injured by the flying fragments. A fire, involving some lubricating oil and insulating materials, followed the explosion, but was speedily suppressed by the fire brigade. This Oldham incident is by no means the first of its kind to be reported during the last few months, and gives one furiously to think whether the margin of safety in peripheral speeds, having regard to the normal fatigue of metals, has not been exceeded in some of the larger rotors now in service. It is speed which tells the tale in the long run, and there is a vast difference between the so-called high-speed reciprocating engines of a decade ago and the very large rotary units, running at speeds of the order of 2,000 to 3,000 r.p.m., which are the order of to-day.

The tendency is towards still greater concentration of power in the single generating set, and the lessons of these recent failures should be taken to heart by the designers of turbo-generators and rotary converters. High speeds in the earlier models where diameters of rotors were more restricted than to-day, allowed a far higher factor of safety, and I saw a 1,250 kw. mixed pressure set running to-day, at full load, which has been in regular commission, without shutting down for more than an hour at a time, since 1916. This particular set was started up early in that year, and stopped at the end of twelve months' service for inspection under the guarantee clause in the contract. It proved to be in perfect order, and was reassembled, and again put into commission, since which time it has been running continuously, with very short occasional stops, never exceeding an hour at a time, for over six years. I wonder how many of the modern giant turbo-sets will achieve a similar record?

Another recent experience may throw some light on power-station failures. An acquaintance of mine had occasion to see the station superintendent at a certain large power station in the Midlands, which, for obvious reasons, shall be nameless. He reached the station in due course, found no one about, wandered the full length of two rows of boiler houses, equipped with chain-grate stokers, still without meeting a soul. He then entered the main building, walked all round the plant, of which three large multi-kilowatt turbo sets were in full commission, ascended to the switchboards gallery, still without meeting anyone, or even sighting a human being, and, finally, in a small office leading off from the gallery, came across a junior girl telephone operator, who, it seems, was the nearest human being to all that mass of valuable plant for a matter of nearly half an hour.

Now, if my friend's experience is anything to go by, one can visualise many thousands of kilowatts of plant simply looking after itself for a good many hours of the twenty-four, and, should anything happen of a nature likely to cause serious derangement of the plant, there would be no experienced official at hand to take emergency measures. It is a well-known fact, of course, that modern power plant is to all practical intents automatic, and, therefore, can, if need be, look after itself for hours at a time without human attention. But that is only if all goes well, and, with high speed, complicated mechanical and electrical gear, there is always the possibility of the unexpected happening. It is quite on the cards that some of the plant breakdowns reported lately have originated from a similar condition of affairs to that above reported. What is the proper venue of a station superintendent, anyhow?

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Trade Union Sabotage?

A paragraph in the *Bioscope* opens my eyes to a practice which I had scarcely credited any wage earner with sufficient malice aforethought to accomplish. It refers to the maltreatment of cinema films at the hands of the trade union operators through whose hands they pass in process of exhibition. Films are very easily damaged and thus rendered unfit for exhibition. Moreover, they necessarily have to pass through so many hundreds of pairs of hands in course of exhibition throughout a wide circuit of cinemas in London and the provinces, that there is every possibility of damage through careless handling or deliberate intent. The writer of the paragraph above referred to stresses this point, and reminds his readers, who number many actual cinema operators, that the Operators' Section of the E.T.U. in Scotland some time ago launched an excellent scheme devised to place all its members "on their honour" to do certain things, and to leave certain other things (which were unoperator-like practices) alone.

As our informant observes, this scheme, unlike most hailing from the Land o' Cakes, seems to have been lost sight of, and the evils the scheme was intended to remedy are as rampant as ever. Several renters have come forward with examples of maltreated films, and in some cases apparently maliciously maltreated films, which damage can only have been wrought with one object, to cause trouble, or in revenge for some imagined wrong suffered by the perpetrator. In the interests of electrical trades unionism, it is to be hoped that the operators' section will do their level best to safeguard the good name of their institution. There is nothing to be gained by wanton damage to employers' property, which must inevitably react, sooner or later, upon the operators themselves. The continued employment of large numbers of cinema operators depends entirely upon the cinema-going public. Once lose popular favour, and the operator, in due course, loses his job. Nothing disgusts the picture-going public more than bad films, and many a cinema has suffered in box-office receipts by showing films which were reminiscent of a continuous heavy rainstorm; whether the effect was due to sabotage or hard wear, the result is the same—lost patronage.

(Im) Propaganda.

I would direct my readers' attention to the letter from Mr. Justus Eck which appears in another column. He deals with a paper read by a Mr. A. E. Bawtree, before a recent meeting of the Royal Photographic Society, dealing with the alleged dangers to eyesight in domestic electric lighting and cinema picture displays. Although cleverly conceived and based on plausible arguments, the paper in question bristles with inaccuracies, which, if uncontradicted, are calculated to do much harm to electric lighting and cinema interests in the lay mind, as well as to modern incandescent gas lighting interests. This is indeed propaganda of a very dangerous and unwarranted kind, and it behoves everyone interested in our industry, as well as in the associated industries of the gas supply and cinema proprietors, to co-operate in neutralising the effect of Mr. Bawtree's paper.

This gentleman, who may be quite disinterested in his efforts to prove that modern illuminants are depriving us of the sense of vision, is a staunch advocate of the old-fashioned wax candle, but I scarcely think even Mr. Bawtree would care to prepare the details of his very interesting paper, and carry out all his duties after sunset, by the aid of the light which was all our grandfathers and grandmothers, a hundred years back, had at their disposal. I am not an ophthalmic expert, but I am open to wager that the best wax candles and tallow dips of the last century wrought far greater havoc to human eyesight than the properly diffused illumination from the most efficient half-watts of to-day.

Wall Plugs and Interchangeability.

It has remained for the E.D.A. to ventilate, by means of a very effective folder, a crying evil of the accessory trade which has been with us for years, and in spite of the good work of the British Engineering Standards Committee. Under the apt title, "A Check on Business and How to Avoid It," this pamphlet, E.D.A. No. 344, directs attention to the difficulties arising out of the existence and sale of so many different gauges and patterns of wall plugs and sockets for use in connection with electric lighting, cooking, heating and small power appliances. Having outlined the evil which exists and directed attention to the existence of an approved standard, the pamphlet advises all consumers and contractors, as well as retail traders, to insist wherever possible that the plugs and sockets used on any installation shall be to B.E.S.A. standard dimensions. As as example of the need for this publicity it has been stated that the 5 ampere two-pin plug is made in no less than thirty different patterns and sizes (*verb. sap.*).

The Word of an Englishman.

I notice with sincere regret that in the report on Mexican trade, recently supplied to our Department of Overseas Trade at Westminster, by Mr. Norman, who is the British Commercial Officer at Mexico city, he refers to the fact that the British word is not what it was before the war. This is a tendency which must be fought at all costs. For generations the phrase "The word of an Englishman" has been a proverb throughout Latin-America, and our business houses and individuals must maintain that reputation for integrity and quality or we shall lose one of our greatest assets. In those great markets, which are at present only the mere coast-line of a continent, with enormous possibilities of trade, we face the keen competition of the world, and it is therefore up to us not to lose any of our initial advantages. British capital and enterprise have helped to develop many of the republics, and we want to obtain all the orders we can in order to keep our factories going for the sake of our great manufacturing towns and districts. True, conditions here have been responsible for various broken promises in regard to delivery, etc., but as Mr. King says, commercial travellers and traders generally must remember that "reputation for precise fulfilment of contracts is one of our strongest assets."

ELEKTRON.

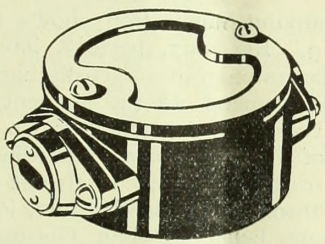
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THE DUREX WIRING SYSTEM.

The rapid increase in the use of lead-covered and cab-tyre sheathed cables for electric light and power installations during the last few years has clearly demonstrated that the future prosperity of the electric wiring industry is mainly dependent upon low installation costs. Every responsible engineer will agree, however, that unless low-priced installations are erected on sound mechanical and electrical principles, the ultimate effect upon the industry will be detrimental rather than beneficial.

The Durex system of electric light and power wiring, for which basic patents have been granted, has been introduced by Simplex Conduits, Ltd., after thorough investigation of all wiring systems in use to-day.

In the design of the component parts, practicability and technical merit have been considered of primary importance, yet the total erection and maintenance cost of a Durex installation is remarkably low. The system complies with the I.E.E. rules, and comprises a range of fittings and twin or triple-core flat metal sheathed or cab-tyre cables. When the former are used the system is known as the Durex D.M.S. (durable metal sheathed) system, and when the latter as the Durex C.T.S. system.



Standard cables are listed in six sizes, twin from 1/.044 (6.1 amps. at I.E.E. rating) to 7/.044 (31 amps.), and in three sizes triple-core from 1/.044 to 3/.044. The metal sheath in the D.M.S. system is made of an almost incorrodible alloy possessing considerable strength and flexibility, and this cable may be used for all ordinary installations in conjunction with any of a most comprehensive range of fittings, mounted in metal outlet boxes or ironclad switch and fuse gear provided with the Durex conical water-tight and gas-tight gland, which positively ensures electrical continuity. The illustration shows an outlet junction box, whence it can be seen that when the cable is placed between the lead bonding clamps it is firmly gripped by them as the conical gland is screwed into position in the box, which is accurately machined to jigs and provided with a counter-sunk hole in the back for screwing to the wall or other convenient support.

Durex D.M.S. cables may be laid between floors and ceilings, lath and plaster and other hollow partitions and walls without further protection, but where they are subject to mechanical injury, as in "down runs" to switches, or where buried in cement, etc., it is recommended that they are protected by a short length of $\frac{5}{8}$ in. conduit connected to the switch outlet box by means of the standard conical gland casing.

The Durex C.T.S. system is a very practical system for all exterior wiring, and should find very extensive application in the electric light and power wiring of chemical works, shipbuilding yards, railway sheds, colliery outbuildings, etc., as it completely provides the necessary degree of protection to C.T.S. cables at junctions to the fittings and other electrical apparatus with which it is connected.

Fuller details may be obtained from Simplex Conduits, Ltd. (Garrison Lane, Birmingham; 113/7, Charing Cross Road, London, W.C.2, and from their various other branches).

Correspondence.

DANGEROUS PROPAGANDA.

The Editor of ELECTRICITY.

SIR,—With about one hundred others I attended a meeting, yesterday, at the Royal Photographic Society to hear a lecture by Mr. A. E. Bawtree, F.R.P.S., on "The Dangers to Eyesight in Domestic Electric Lighting and Kinema Picture Displays," of which the following is the printed synopsis:—"Theoretical considerations — collected evidence — demonstrations in support of the contentions—effects—of electric light shown to be injurious by reason of its colour, intrinsic qualities and mode of generation—the kinema picture display shown to impose the utmost strain upon the eyes."

On the seats for the audience there was a printed slip headed:—

DANGERS IN ELECTRIC LIGHT.

1. Instantaneous lighting up.
2. Intrinsic intensity at least eighty times that of a flame.
3. Large volume of light obtainable.
4. Difference in colour to that of a flame.
5. Much ultra-violet emanation.
6. Possibility of X-ray, Electron and undiscovered emanations.
7. Induced currents from alternating supply.

DANGER IN THE KINEMATOGRAPH [*sic*] DISPLAY.

Intermittent [*sic*] intervals of darkness of constant periodicity.

Mr. Bawtree, a fluent speaker, has assembled many interesting lantern slides and much data from well-known sources, and gives a lecture eminently convincing to the lay mind, and herein lies the danger, as his apparent object is the substitution of the wax candle or resin torch of our ancestors for modern illuminants of all kinds, including gas flames and mantles.

At the meeting, every person, including the chairman, who joined in the discussion, pointed out the errors and fallacies embodied, so that the display of red and white wax candles found no supporters.

The object of this letter is to ask you to warn members of the electrical industry of the possibility of this well-prepared lecture being repeated at local societies where discussion is not permitted, and to get members to attend lectures where discussion is permitted and then easily destroy the unique accusations built on assumptions and false analogies.

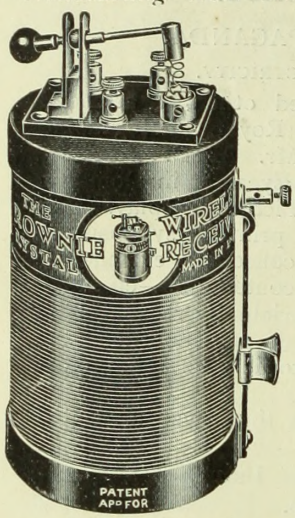
The lecturer mentioned that there would be a full report, I assume in the *Journal of the Royal Photographic Society*, and this should be obtained and read, and it will be there seen how such appreciated names as those of Dr. Sylvanus Thompson and Dr. Kenneth Mees are cunningly introduced to give an air of verisimilitude to an otherwise bald and unconvincing yarn.—Yours faithfully,

February 14, 1923. JUSTUS ECK.

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A WIRELESS RECEIVER FOR 7s. 6d.

We give herewith an illustration of a small crystal radio receiving set, the component parts of which are now being put on the market at the marvellous price of 7s. 6d. What is more, it is a really serviceable instrument, and the writer has listened through it to the broadcasting from Marconi House, when the voice might have been that of a speaker in the same room. The parts are sent out carefully packed, with clear instructions as to assembly, and consist of an ebonite detector panel with all holes properly drilled, a wound induction coil, tuning slider, screw clamp, crystal cup, best quality crystal, a universally jointed detector permitting accurate and easy adjustment, together with the necessary screws and parts for completing the receiver as shown above. The phones are not included, as users are left to purchase the type which best suit the personal fancy and purse, but the actual set as shown is a marvel of value, which can be put together by any man of average intelligence, and we anticipate that it will make quite a stir in the wireless world. The inventor is an electrical engineer who is well known in another branch of engineering but who has lately turned his talents to wireless. He has perfect confidence in the claims which he makes for his novel instrument, and these are supported by our own tests as referred to above.



Complete instructions and drawings for the wiring connections are included with each outfit, and it would be difficult to conceive anyone failing successfully to erect and wire the component parts.

Certainly constructing a wireless outfit such as this not only brings delight to the listeners-in, but is an invaluable introductory education to wireless science.

G.E.C. ELECTRIC LIGHT FIXTURES.

We have received from the General Electric Co., Ltd., Magnet House, Kingsway, W.C.2, a copy of a new edition (the 16th) of their catalogue of electric light fixtures (section F. of complete catalogue). This new list, which is being mailed to the company's trade customers, contains some 216 pages of designs, many of them entirely new, which combine the requirements of modern lighting with artistic effect.

All list prices have been revised to include reductions in the cost of labour and material to date of issue, and it may be expected that these prices will now remain stabilised.

The list is a new departure in that it is produced throughout by the photogravure process. Four beautifully reproduced colour designs of typical fittings are included, and altogether the list is, we imagine, the most comprehensive and complete volume of its kind.

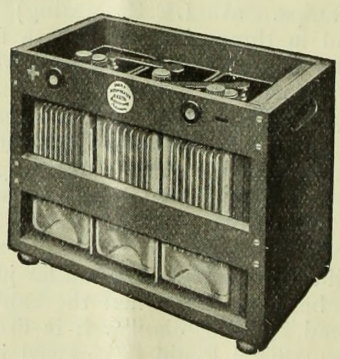
The arrangement of the sections of the catalogue is simple and logical and easy for reference. The excellence of the illustrations will render the list of the greatest value to dealers, architects and engineers in aiding them and their clients to make a selection.

CESSATION OF WRITTLE WIRELESS CONCERTS.

Wireless amateurs will learn with regret that they will no longer be entertained by the burlesques and parodies from the Writtle wireless station which have been enjoyed so much each Tuesday evening during the last twelve months. They were inaugurated by the Marconi Scientific Instrument Co., Ltd., one of the Associated Marconi Companies, in February, 1922, to provide British amateurs with material for experimental purposes which had not previously been available in this country; but now that there is an abundance of telephony available from the broadcast stations, the company considers that its enterprise has served its purpose and that Writtle may rest upon its laurels.

"HART" ACCUMULATORS FOR RADIO WORK.

The accompanying illustration shows the "Hart" 6-volt "Meg. 9," Ref. 8c7, battery, having capacity of 40 ampere hours on continuous discharge, which is now greatly in demand as the filament battery for radio work. The Hart Accumulator Co., Ltd., hold large stocks of these to meet immediate demands, both at their Stratford works, and also at their various branch depôts throughout the kingdom, including Belfast, Birmingham, Bristol, Dublin, Glasgow, Manchester, Westminster and York.



The battery consists of three cells in glass boxes with sealed ebonite lids and vent plugs, and is contained in a waxed wood crate with finger grips on ends, or strap carrying handle as preferred by purchasers. The leading wireless companies in the country are large users of these batteries, and users generally declare it to be the most serviceable battery for valve work at present offered. These batteries are made in portable form and in 4- and 6-volt, from 20 to 60 ampere hours continuous capacity.

Telephone Statistics.—According to the *Automatic Telephone*, on December 31 last there were estimated to be 23,238,106 telephones in the countries specified below. Of these 'phones 1,231,557 were automatic—a percentage of .053. The percentage of automatics in Africa is .008, Asia .023, Europe .049, Oceania .133, North America .053, U.S.A. .051, and South America .062.

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Questions and Answers by Practical Men.

RULES.

QUESTIONS: *We invite our readers to send us questions, preferably on technical problems that have arisen in actual practice. Questions which we consider of sufficient interest to our readers will either be replied to under "Answers to Correspondents" or replies will be invited from our readers. One shilling will be paid for the question which we select for competitive replies in this column*

ANSWERS: *A fee of 10s. will be paid for the answer which we consider shows the greatest merit, and 5s. for the one we select as second best. In judging the replies, importance will be attached to clearness and conciseness, as well as accuracy. The Editor reserves the right to make no award, or to accept only one reply, if, in his opinion, the answers received do not possess sufficient merit. Competitors desiring the return of their manuscripts, if unaccepted, should enclose stamped addressed envelope.*

Write on one side of the paper only, and if diagrams are sent, draw them on a separate sheet of paper attached to the manuscript. Competitors may adopt a "nom de plume," but, both in the case of questions and answers, the competitor's real name and address must be sent with the manuscript as a guarantee of good faith No correspondence will be entered into with regard to successful replies. The Editor's decision is final.

Commencing with Question No. 101, *a Diploma of Merit will be awarded to the six competitors who win the first or second prize the most times during the next twelve months.*

The words "Questions and Answers" or "Q" and "A" should be placed a the top left-hand corner of all letters intended for this column.

QUESTION No. 155.

Can anyone give me details which govern the selection of a fuse carrier? I desire some for use on the following service:—Volts 440 d.c., 50 amperes, three wire.—"Cable."

QUESTION No. 156.

Can any reader give me information concerning a good method of indirect lighting. I have a small study where I do a lot of drawing, and I find the ordinary electric light is very trying for my eyes.—"Pen."

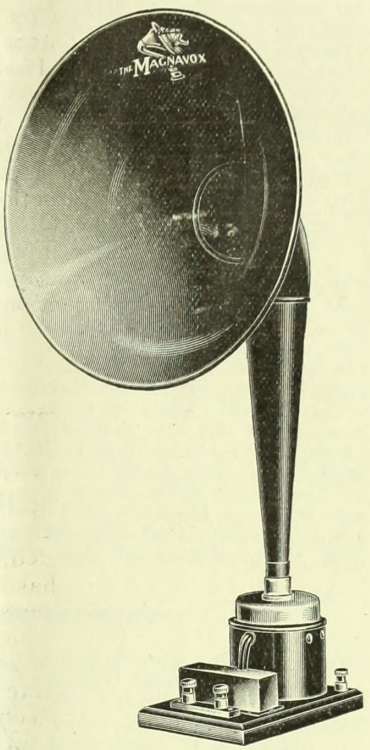
(Replies to Questions 155 and 156 must be received not later than March 31, 1923.)

Reviews of Books, &c.

[Books noticed in this column will be sent from ELECTRICITY *Office to any part of the world, for the published price, plus ten per cent. for postage (minimum 2d.) and orders will be appreciated.]*

B.E.S.A. PUBLICATIONS NOS. 109-1923 AND 110-1923.—These specifications were first issued in 1921, but it has been found necessary to revise the sections covering the tests. As in the first editions, the specifications do not include switches or circuit breakers for use with series motors, circuits of high inductance or traction circuits, all of which may require a higher breaking capacity than is specified therein. A distinction between an isolating switch, a switch and a circuit breaker is laid down as follows:—"An isolating switch is intended only for interrupting the circuit when there is no load current. A switch is suitable for breaking a load-current; and a circuit breaker is suitable for interrupting abnormal conditions such as that of short circuit." A number of terms used in modern switchgear practice have been defined and a series of standard sizes has been included. Dimensions of back connections and the distance apart of the stud centres of knife switches have been agreed upon so as to secure a reasonable amount of interchangeability without interfering with details of design. Since it is not practicable to take out a complete range of tests on every switch or circuit breaker, the tests have been divided into two categories, *i.e.*, tests which are carried out on every switch or circuit breaker and those which are carried out only on a switch or circuit breaker of a type. Copies of the specifications may be obtained from the Offices of the B.E.S.A., 28, Victoria Street, Westminster, S.W.1. Price, each 1s. net, post free 1s. 2d., or from the office of ELECTRICITY.

STERLING RADIO RECEIVING SETS.



Publication No. 342, just issued by the Sterling Telephone and Electric Co., Ltd., Telephone House, 210, Tottenham Court Road, London, W.1, is full of interest for listeners-in under the Postmaster-General's broadcasting licence, as well as for amateur experimentalists in need of accessories.

Standard sets offered range from the Sterling No. 1 crystal set, which has a range of 25 miles from the broadcasting station, and is also furnished with an extra coil, enabling it to receive time signals from the Eiffel Tower. Tuning facilities consist of two radial switches controlling inductance tappings, and the set includes a pair of 2,000 ohm headphones.

In valve sets the Sterling Company offer a two and three-valve combination respectively, for broadcast licence only, and with a range up to 100 miles on headphones, or 50 to 60 miles on loud speaker. In each case a convenient switch enables the user to change over promptly from headphones to loud speaker. The valves are completely enclosed and protected in the body of the case.

For experimental licence holders there is the Sterling No. 4 four-valve set, embodying one H.F. amplifier, one detector, and two note magnifying valves. Each valve has a separate switch and its own control resistance. The tuner is contained in a separate unit, coil holders being provided for plugging in honeycomb coils. This set enables radio concerts to be picked up anywhere in the United Kingdom.

In loud speakers, the popular method of reproducing broadcasted music and speech, the company specialises in the Magnavox Junior and Senior loud speakers, illustrated, both of which are already well known to our readers, and which require the application of a field current to yield the very best results in regard to volume and clearness. For use with these Magnavox loud speakers there are also listed two and three-valve power amplifiers, which considerably augment the volume of sound produced.

Full instructions for coupling up and operating the Magnavox combinations are a feature of the list, which also deals with a range of accessories, including Sterling intervalve transformers, and some useful hints and suggestions for getting the best results.

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Ready in a Few Days.—We are pleased to say that the 1923 edition of the "Practical Electrician's Pocket Book" will be ready very shortly. It was delayed by the dispute in the binding trade. As usual, it has been most carefully revised, and among the new items is a splendid chapter on broadcasting by an experienced engineer. It represents better value than ever, and if you want to secure a copy you should send 3s. 4d. at once direct to the publishers, S. Rentell and Co., Ltd., 36, Maiden Lane, London, W.C. 2, and ask them to mail it to you as soon as issued.

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THE N.A.S.E. DINNER.

The National Association of Supervising Electricians is one of the youngest and, at the same time, one of the most virile of registered trade unions. Its organisation is based on the proper use of brains and mental ability, with the aim of building up and improving the status of its members by cordial co-operation between employers and employed. The result is that it is making rapid and healthy progress, of which ample evidence was shown on the occasion of the annual dinner held at the Holborn Restaurant on the 17th inst., when Mr. W. E. Highfield presided over about 160 members and visitors, including Mr. Frank Gill (Pres. Inst. E.E.), Sir R. Burton Chadwick, and other well-known gentlemen. After "The King" had been duly honoured, Sir Burton Chadwick rose and said that, in the unfortunate absence of Major Vincent Smith, he had been called upon at a moment's notice to propose the toast of their President, Mr. W. E. Highfield, and went on to say that his (the speaker's) ignorance of everything appertaining to electricity was abysmal, although he acknowledged with pleasure his great indebtedness to our science for the manifold advantages which it brought in its train. One of the finest things in Great Britain at the present time was the spirit of co-operation and enterprise, which was being shown more and more by societies and associations such as the N.A.S.E., and Mr. Highfield had proved himself a true trade union leader in the way in which he was ruling and guiding its destinies, a remark which was received with much applause. In reply, the President thanked all the members of the Association for the kindness and courtesy which he had always received from them, and referred especially to the assistance so wholeheartedly given by the secretary. (At this point Mr. Brammer tried to dive under the table, but could not.) He thought the success of the Association was reflected in the large attendance that evening, and also referred with pleasure to the presence of Mr. Gill, the President of the I.E.E. In addition, he said that much was due to the way in which the members worked together for their own good and for that of the industry. In fact, they all seemed to be part of one great family. The Association was stronger than ever, and he was only too glad to think that he would be associated with them all next year.

The toast of "The Association" was then very ably proposed by Mr. Frank Gill, who opened his remarks by stating that they could not have had such presidents as had ruled over them during recent years without their leaving their impress on the Society. It was a splendid achievement to have won recognition as an Association and as a trade union having a really excellent organisation, and it augured well for the future. He referred especially to the importance of the educational scheme and how necessary it was that our young men should be adequately trained. Otherwise, it meant a great loss to the efficiency of the nation, and he did not see how we could make our way without such training. We must think particularly of administration, economics and psychology. In other words, as an engineer must learn when and why a bearing gets hot, so also should he learn when and why a man gets hot. (Laughter.) We must pay attention to the roots from which a man's motives grew and must encourage ideals. Such ideals, indeed, were even above one's thought of the nation as a whole, as by such ideals the nation was built up. He had unbounded faith in the future of the electrical industry, which, he believed, was going to be one of the very biggest industries in the world. To think that needs enthusiasm which, in combination with change, is one of the essentials of continued growth, and that gets back again to education. We must keep our minds flexible. Mr. Gill also referred with pleasure to Mr. Baldwin's speech as reported in that day's papers, and said that the cure for our present troubles was real hard work combined with an absolute avoidance of waste. To do that it is necessary to teach labour to help you, for which education in psychology is so essential. He wound up a most interesting speech by quoting two examples of what this country can turn out, viz., first-class coal and first-class labour, and naturally the human element was the more important.

In reply to Mr. Gill's well-reasoned address, Mr. Windibank, in a clear and well thought-out speech, referred first to the age of the Association and its present strength. He mentioned that it was actually registered as a trade union in 1918, and then went on to say that nowadays the man in the street knows he can rely on the people with the black coats who supervise the work which he wishes carried out. Undoubtedly the Association's future prospect was a happy one, and after alluding cheerfully to the report which had just recently been issued, he said that one of the principal items referred to by Mr. Gill had been education, with which he felt all present were in cordial agreement. Their paper, *Contact*, was of direct educational value, and they aimed at its further improvement. He was glad to think that the Association was represented on two of the I.E.E. Committees, and mentioned also the cordiality and advantages of the combined meetings with the Association of Engineers-in-Charge. A new committee had been set up to deal with patents, and other important committees were in session. He claimed that they had a much more broadminded grasp than the man in the street of the advantages and disadvantages of trade unionism. The first thing for them to do was to have the good of the industry at heart. Co-operation and readiness for arbitration should be their watchwords, and a high standard of technical ability was, of course, an essential qualification, which would itself involve recognition of the status of the Association and its members.

Mr. J. S. Highfield followed with the toast of "The Visitors," in which he referred humorously to the fate which would have overtaken certain imaginary workmen engaged on a job in Sir Burton Chadwick's house, as well as to the presence of Mr. Lang, of Callender's Cable Co., and Mr. W. E. Warrilow, the latter of whom replied in a speech which evoked much laughter. Mr. Whitley was eloquent in his praise of the "Press," and in the regrettable absence of Major Masters, who had left to catch a train, Mr. Rentell acknowlelged the courtesies so kindly rendered. The various speeches were interspersed with a first-class musical entertainment, which was much appreciated by all present, and on the motion of the President a cordial vote of thanks was passed to those responsible for the very successful evening's arrangements, after which the meeting closed with "Auld Lang Syne."

S. R.

Write.—If you have not received a copy of the Sunco monthly price list of electrical supplies, write and ask for it.

"**Hints on Wiring.**"—Interested contractors and installation engineers should write Messrs. Henley for the booklet referred to in their advertisement on the front cover. It is worth it.

Sales Conference.—The next E.D.A. Sales Conference will be held at Caxton Hall on March 2 at 7.30 p.m., when Mr. A. G. Whyte will read a paper on "The Industry, the Press, and the Public."

Harmony.—The Ladies' Night concert of the Electro Harmonic Society, which was held on the 14th inst., was a great success. It was remarkably well attended, and the programme provided was much appreciated, so much so that the demand for encores caused it to run on to a later hour than usual, but everybody seemed to enjoy themselves thoroughly. Hearty congratulations to Mr. Sillar, Mr. Hughman and the Musical Committee generally.

Don't Forget This.—We wish to remind our readers that the fourth annual smoking concert of the Informal Meetings Section of the I.E.E. will be held on Monday next, the 26th inst., at the Engineers' Club, Coventry Street, at 7.45 p.m. Visitors who may not be actual members will be admitted to membership privileges for the evening. Friend K. V. A. Warrilow will occupy the chair, and we hope that he will be supported by a right goodly attendance. Perhaps he may spring a few new tales for the occasion. He is almost certain to have some good broadcasting yarns.

Meetings.—The I.E.E. will meet in the Institution on Thursday, March 1, at 6 p.m. Report presented on behalf of the British Electrical Research Association by Messrs. S. W. Melsom and E. Fawssett on "Permissible Loading of British Standard Paper-insulated Electric Cables." Arrangements have been made for members to dine together at the Engineers' Club, Coventry Street, W., after the meeting. The charge per cover will be 5s. 6d. Those wishing to be present at the dinner are requested to send their names to the Secretary in advance either in writing or by telephone.

NEW BOOKS PUBLISHED.

"Lockwood's Builder's and Contractor's Price Book, 1923." Cl. 8vo, 777 pp., 7s. 6d. net.

"Direct Current Machinery," by Pender. Cl. 8vo, 314 pp., 146 illustrations, 15s. net.

"Handbook for Electrical Engineers," by Pender. Cl. 8vo, 2,263 pp., with hundreds of illustrations, second edition, 30s. net.

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Various Items.

Faraday Medal.—The Council of the I.E.E. have awarded the Faraday Medal to the Hon. Sir Charles A. Parsons, K.C.B., F.R.S., Hon. Member of the Institution.

Bolton.—A spacious showroom has been opened in Deansgate by Messrs. Walter Bradley (Engineers), Ltd., motor-cars and general electrical appliances being on view.

Chorley.—The cost of installing electric heating and lighting at the Poor Law institution was £11,205. In addition, a storage battery and booster set was installed at a cost of £1,000.

Annual Dinner.—The annual dinner of the B'ham and District Electric Club will be held on Friday evening, March 2, at the Grand Hotel, Colmore Row. An excellent menu and first-class programme have been arranged.

Wanted.—Messrs. T. Rutter and Co., of 35, Victoria Road, Aberavon, Port Talbot, wish to know the names and addresses of makers of moulds for casting accumulator grids and any other plant required for the manufacture of secondary batteries. If any reader or advertiser can give them this information they will be grateful.

Apparatus for Sale.—An advertiser has for sale a Bridge Megger, for which he invites offers. Also, the Porcelain Accessories Co. are anxious to sell best English porcelain ceiling roses, cut-outs, aerial insulators, etc.; and another advertiser is pushing conduit fittings, cables, etc., from stock. For particulars, see small advertisements page.

A.M.I.E.E. Examination.—It is proposed to hold the Associate Membership Examination of the Institution of Electrical Engineers in London and other places (at home and abroad) towards the end of April, 1923. Entry forms and full particulars can be obtained from the Secretary of the Institution, Savoy Place, Victoria Embankment, London, W.C. 2.

Meetings.—The Junior Inst. of Engineers will meet at 39, Victoria Street, S.W.1, on Friday, 23rd inst. Lecturette, "Characteristics, Operation and Maintenance of Underground Cables," by A. J. Tracey (slides).——Also, on Friday, March 2, lecturette, "Glass-forming Machines," by C. Saxton (slides); and on Friday, March 9, "Steel Works Equipment," by R. C. D. Fell (slides). All at 7.30 p.m.

Engineering Exhibition at Olympia.—We understand that excellent progress is being made in regard to the arrangements for the Shipbuilding, Engineering and Machinery Exhibition which will be held at Olympia in the coming autumn. It is being supported by a very large number of firms who are well known in the various industries which it covers, and any firms who are anxious to get good space should make a point of writing without delay to the Exhibition Organisers, Messrs. F. W. Bridges and Sons, Ltd., Avenue Chambers, 4, Vernon Place, Southampton Row, London, W.C.1.

Obituary.—All readers who have had business relations with Messrs. Siemens, in Upper Thames Street, will regret to hear of the death (on the 9th inst.) of Mr. A. Rowley, who has been associated with the Siemens Lamp Sales Organisation for the past eleven years. He recently underwent two serious operations in St. George's Hospital, and although these appeared to have been fairly satisfactory, complications set in with fatal result. He had a wide circle of friends in the electrical industry, and was well known in the London area. The interment took place on Thursday, 15th inst., at Hanwell Cemetery, and was attended by many of his old friends. Peace be with him. He was one of the best.

A Happy Evening.—On Tuesday, 13th inst., the staff and employees of the D. P. Battery Co., Ltd., at Bakewell, had a real good time at the Town Hall as the guests of the company. In one large room there was a whist drive with some first-class prizes; in another an enjoyable dance and concert; and in the Board Room there were the refreshments necessary to revive any wearied whist players or dancers. Mr. J. Waddell, the manager of the company, presented the prizes to the winners, and after that ceremony Mr. Hough, the chairman of the local branch of the Workers' Union, expressed the thanks of all present for the very happy entertainment which the company had provided. Mr. Robert Blackwell, the oldest employee of the firm, speaking on behalf of his fellow-workers, then presented Mr. Waddell with a smoker's set and a silver-mounted ebony walking-stick as a memento of that happy occasion. The entertainment terminated at 2 a.m., and was an excellent testimonial to the happy feeling which pervades the works of this well-known undertaking.

Blackpool.—Electric current is to be supplied free for providing illuminations during carnival week to tradesmen who desire to make their premises attractive. A deputation of the Corporation is visiting Nice with the object of picking up hints for the carnival.

A Useful Bargain.—Messrs. S. Rentell and Co., Ltd., are offering for sale plug type switchboards in which six bars can be plugged on to any one of eight others. The equipment includes six fuses and lightning arresters, and by removing the fuses, twelve bars could be plugged in various combinations with the underlying eight. The whole constitutes a switchboard which can be used for experimental work in wireless circuits, for changing meter test circuits, and so on. They were made during the war by leading firms, such as the Ediswan Co., Sullivan, Elliott, the A.T.M. Co., Ltd., etc., and cost originally about £6 apiece. The price is 17s. 6d. each net, post free in the U.K. If you want one before they are all sold, send your order to 36, Maiden Lane, London, W.C.2, without delay.

Trade Notes.

A catalogue and price list of **Hopkinson Induction Motors** has reached us from the makers at Seagrave Road, West Brompton, S.W. 5. It will be of interest to all who are in the market for one-, two- or three-phase motors and starters.

A first-class catalogue (No. 3,680) of electric-light fittings has just been issued by **Messrs. Drake and Gorham Wholesale, Ltd.**, 67, Long Acre, London, W.C. 2. It is a beautifully printed work and contains a wealth of illustrations of the latest designs in brackets, table pillars, standards, pendants, glassware, shades, etc., for direct, indirect and semi-indirect types of lighting. It will therefore prove of use to all electrical factors and contractors, and has the advantage that the title page can be removed neatly and the catalogue lent to any private client, without in any way indicating the name of the manufacturing firm.

Two illustrated pamphlets on details of H.T. work can be obtained from the **Metropolitan-Vickers Electrical Co., Ltd.** One bears the title "High-voltage Switchgear Design" and the other "Electrolytic Lighting Arresters." They are from the pen of Mr. W. A. Coates, and can therefore be regarded as really authoritative expositions of these difficult subjects.

Messrs. Crosby Lockwood and Son, the well-known technical publishers, of Stationers' Hall Court, London, E.C.4, have just issued their latest quarterly announcement of new publications, and will be pleased to send a copy, post free, to any of our readers.

A table showing a few representative sizes of Wild-Barfield furnaces, with productions, has just been issued by **Automatic and Electric Furnaces, Ltd.**, of 173/5, Farringdon Road, London, E.C.1, who are well known as specialists in the heat treatment of carbon and low alloy steels. Demonstrations are given daily by appointment.

Messrs. Pettigrew and Merriman, Ltd., of 122, Tooley Street, London, S.E.1, have taken up the London agency for the Ashley Wireless Telephone Co., Ltd., of Liverpool, whose advertisement appears in another page. They are also associated with the sale in the London district of the manufactures of the Automatic Telephone Mfg. Co., Ltd., and will be pleased to answer inquiries about their products. London wireless readers should get in touch with them.



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A POPULAR SCIENTIFIC WEEKLY JOURNAL
ELECTRICITY
A PRACTICAL TRADE JOURNAL

MARCH 2, 1923.

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ELECTRICAL RESISTANCE FURNACES AND THEIR USES.

During recent years electrical resistance furnaces have been adopted widely in industrial service with very satisfactory results, but little information has hitherto been published concerning them either in books or in technical journals. We are glad therefore to be able to place before our readers the principal facts and figures from a valuable paper read recently by Mr. Chas. R. Darling before the Royal Society of Arts.

The first electrical resistance furnace to come into general use in the laboratory was that introduced by Heraeus in 1902. This consisted of a porcelain tube wound externally with a spiral strip of platinum foil and encased by lagging material to reduce loss of heat by radiation. A temperature of 1,500° C. could be reached in these furnaces, but, apart from the cost of the platinum (then high and since much higher), there were grave difficulties which prevented these furnaces from coming into industrial use. The most serious of these difficulties was that occasioned by the high temperature coefficient of resistance of platinum, which metal has about five times as great resistance at 1,300° C. as at 0° C. In other words, a platinum-wound furnace designed to carry 20 amperes when hot would allow 100 amperes to pass when the winding was cold, if connected straight across the normal voltage. A current rush of this magnitude would be very undesirable in itself and would probably result in damage to the winding. The only means of avoiding it is to connect an external resistance in series with the furnace on starting. This naturally delays the heating of the furnace itself and involves waste of energy, besides which the manipulation of the resistance and the serious consequences of a mistake therein combine to make the equipment unsuitable for industrial service.

Developments in Heating Elements.

The sudden awakening of interest in the heat treatment of steel about the year 1906, and the fact that the temperature required for heat-treating carbon steel is below 1,000° C., led to the use (at the National Physical Laboratory and elsewhere) of furnaces with nickel windings. Nickel melts about 1,450° C. and does not readily oxidise below 1,000° C. This material, when wound on tubes of vitrified silica, enabled much excellent work to be done, but it was the introduction of nickel-chromium alloys in 1907 which gave the great fillip to the development of the electric resistance furnace and enabled it to be used industrially by unskilled operators. The two great advantages of the nickel-chromium alloys are that they do not oxidise even at 1,000° C., and that the temperature coefficient of resistance is very small, so that a furnace wound with nichrome wire can be switched straight on to the full supply voltage and brought to full heat in minimum time and without waste of energy in regulating resistances.

The heat-treatment of high-speed steels requires temperatures exceeding 1,300° C., and this is above the range of the nichrome wire, which, even when specially selected, can hardly be used above 1,200° C., and is better restricted to 1,000° or 1,100° C. Molybdenum, which melts at 2,600° C., and tungsten, which melts at 3,200° C., are fairly cheap metals, but unfortunately they oxidise readily in air when heated, and the only method of using these metals for electric resistance furnaces is either to evacuate the space surrounding the heating coil or to fill this space with an inert gas such as hydrogen or nitrogen. Either of these expedients can be used in the laboratory, but neither can be adopted in general industrial service. It is true that a molybdenum-wound furnace surrounded by hydrogen, and with hydrogen supplied to the furnace tube itself, is used to anneal tungsten wire for lamp filaments, but this is a special application, and furnaces of this type are certainly unsuitable for use by ordinary workmen in the heat-treatment of high-speed steels. Molybdenum and tungsten heating elements share with platinum the disadvantage of high temperature coefficient of resistance, and must therefore be used in series with a compensating resistance until they are hot.

The same difficulty, that of easy oxidation, hinders the use of carbon as a heating element. This material will withstand a higher temperature than any other known material (its melting point is 3,700° C.), and it is also very cheap, but unfortunately it begins to oxidise about 600° C., and burns in air very readily—as witness the common fire.

Another unfortunate characteristic, from our present point of view, is the relatively low resistance of carbon and the fact that its resistance decreases with increasing temperature. A solid tube of carbon can be used as a self-heating furnace chamber, but the current required is heavy and the voltage applied must be correspondingly low. By cutting the tube into rings the total resistance is greatly increased, due to the relatively high contact resistance between adjacent rings, and a furnace of this type has been used successfully for experimental work. The granular carbon furnace is also interesting and, in the laboratory, very useful. Current is passed through a layer of carbon granules (of a size retained on a 20-mesh sieve) which surround the refractory chamber. Current is led into the carbon by iron electrodes which are embedded where the area of the carbon is large and the temperature correspondingly low. At the centre, next to the refractory

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chamber, the cross section of the path through the granules is small and a very high temperature is reached. Due to the variable resistance of the carbon the granules are generally heated more intensely at some parts of the furnace than at others. This difficulty can be overcome by using a number of electrodes which are switched in and out of circuit as required to divert the current from one part of the furnace to another, thus maintaining uniform temperature. This, again, is obviously an expedient which can only be employed in the laboratory.

The most generally useful form of carbon furnace is undoubtedly that due to Hancock, which consists of a number of carbon rods in series running along the outside of the refractory chamber and forming a cage round it. The ends of the separate rods are connected by graphite strips, and both are protected from oxidation by being covered with a carborundum composition which is highly compressed and then baked at high temperature. A furnace of this type can be operated at 1,500° C. to 1,700° C., and, with a suitable refractory, it could probably be worked at 2,000° C. The life of the carbon rods does not depend upon the maintenance of a vacuum or upon surrounding with inert gas; on the contrary, the rods can be bought ready for use at a trivial cost, and when it becomes necessary to replace a set this can be done in a few minutes without difficulty.

Refractories.

From what has already been said, it will have been gathered that the refractory material for the furnace tube or chamber is quite as serious a problem as the heating element itself. Porcelain was used for the original platinum-wound tube furnaces, and was satisfactory for that purpose except that it was very liable to crack. Vitrified silica is an ideal refractory for use for nichrome windings, but it is inadvisable to use it with platinum because silica and many forms of fireclay cause platinum windings to fuse. Alundum (fused aluminium oxide, powdered, bonded and baked) is now generally employed for platinum-wound furnaces where these are used, and it is probably the best of the materials at present available. As mentioned by one speaker in the discussion on this paper, mica should not be used in conjunction with nichrome windings; in a particular case, a nichrome heater wound on mica failed after a few hours' service at 900° C.

Silfrax, a special form of carborundum, is an excellent refractory for general purposes, and is said to hold up at 2,000° C., but alundum and fireclays droop before this temperature is reached. Zirconia and mixtures of magnesia and zirconia have been reported upon favourably in the United States, but these materials are not easily obtained in this country.

At the temperatures reached by the carbon furnace it is necessary to use lampblack or porous carbon as lagging material, there being no other suitable material which will stand the temperature. Vitreous silica softens about 1,600° C., and becomes crystalline and brittle at about 1,100° C. Alundum will not stand up very well at 1,600° or 1,700° C., especially if it has to carry any weight.

It might reasonably be thought that the temperature within the furnace would be considerably lower than that of the metal heater, but tests by Barfield show that at 900° C. the temperature difference between the heating element and the inside of the furnace is only about 10° C. If it is desired to reach the highest possible temperature, the heating element may be mounted inside the refractory chamber, provided that it will not be damaged or short-circuited by the material to be heated.

Sizes and Performance of Electric Furnaces.

Electric resistance furnaces are now used commercially in all sizes up to about 5 ft. long by 14 in. internal diameter. Smaller furnaces from 1 ft. to 3 ft. in length and from 2 in. to 12 in. internal diameter are generally more convenient for heating small parts, and with such furnaces from 5 lb. to 100 lb. per hour of carbon steel can be perfectly hardened. Electric resistance furnaces are also largely used for melting non-ferrous metals, and up to 300 lb. per hour of brass can be melted in a furnace of this type. Rivets can be heated conveniently in a rotating electric resistance furnace, a typical performance being the heating of 150 rivets, each 2 in. long and $\frac{3}{8}$ in. diameter, by the expenditure of 5 kw. hrs. Representative values of power consumption quoted by Mr. Darling are as follows:—Tubular furnaces wound with nichrome and working at 1,000° C.; furnace dimensions, 1 ft. by $1\frac{1}{2}$ in.; 0.5 kw. for one tube, and 1.2 kw. for four tubes in one casing. Larger furnaces of the same type consume 12.5 kw. for a tube 36 in. by 12 in. diameter; and 5 kw. for a furnace chamber 13 in. by 7 in. by 4 in. A furnace space 14 in. by 4 in. diameter can be maintained at 1,000° C. by the expenditure of 5 kw. (8 kw. for 1,500° C.), using a Hancock sheathed-carbon-rod furnace; whilst a carbon granule furnace will keep a chamber 8 in. by $2\frac{1}{2}$ in. at 1,700° C. by the consumption of 10 kw.

Advantages of Electric Resistance Furnaces.

Though the cost per thermal unit is about three times as high when using electricity at 1d. per kw. hr. as when using gas at 10d. per therm, yet electricity is cheaper than gas for heating small furnaces by the external application of heat. This is because an electric furnace can be lagged so that there is very small loss of heat by radiation, whereas an externally-fired gas furnace is extremely inefficient because the products of combustion must leave the furnace at the full temperature of the latter (otherwise they would cool it). In the case of larger furnaces which can be heated internally by gas, the latter medium is doubtless cheaper than external heating by electricity, but, on the other hand, the atmosphere inside an electric resistance furnace is perfectly pure, whereas the atmosphere in an internally-fired furnace is contaminated by the products of combustion, and may injure work placed therein.

Another important advantage of the electric furnace is the ease with which it can be controlled by a regulating resistance and the accuracy with which any desired temperature can be indefinitely maintained.

As is now well known, the correct temperature at which to quench carbon steels in order to secure the best structure is slightly above the temperature of recalescence, and coincides with the loss of magnetic

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properties in the steel. This fact is utilised in the special magnetic detector fitted to Wild-Barfield furnaces—an ingenious and most successful device which has already been described in these columns (see also *The Practical Electrician's Pocket Book*).*

Another form of magnetic detector, devised by the Hon. C. W. Stopford and Mr. Darling, consists of a magnetically-operated contact breaker which operates equally well on direct or alternating current, and when the steel becomes non-magnetic, announces the fact by closing a bell circuit and giving an audible alarm.

The inherent flexibility and constancy of the electric furnace, coupled with the use of a magnetic detector, enables this equipment to be used by unskilled labour. As a further precaution the Wild-Barfield furnaces are fitted with a silver cut-out loop which melts if the temperature exceeds 961° C. (the melting point of silver), and thus protects the main heating coil from injury by overheating. At the same time, a red alarm lamp lights automatically to call attention to the fact that the cut-out has operated. Apart from the devices already mentioned, the only auxiliary equipment required by an electric resistance furnace is a small switchboard with regulating rheostat and ammeter.

A practical point mentioned in the discussion which may be useful to readers is that round nichrome wires are found to be more durable than nichrome strip; also it is better to use two wires in parallel than a single wire of equivalent section.

Future Developments.

The future of the electric resistance furnace for temperatures up to 1,000° C. or 1,200° C. is already well assured, but it has undoubtedly an even greater future directly heating elements and refractories become available which will withstand temperatures from, say, 1,500° C. to 2,000° C. A cheap alloy not oxidising or melting below 1,800° C., and having a low temperature coefficient of resistance, would be of the greatest service in enabling electric resistance furnaces to be used freely for the heat-treatment of high-speed steels. No such alloy is yet known, but perhaps it may be found in some alloy of tantalum, tungsten or molybdenum. The fact that an alloy of aluminium and nickel in atomic proportions melts about 1,600° C.—*i.e.*, well above the melting point of both its ingredients—is very suggestive. Research directed towards the discovery of a suitable high-temperature alloy should prove a profitable line of work for those in a position to undertake it. Until such an alloy is discovered the best industrial resistance furnace is probably the sheathed-carbon-rod type, which can be built in large sizes and has relatively low current consumption (higher, however, than that of metal-wound furnaces).

In the neighbourhood of 1,700° C. or 1,800° C. much better refractories are needed than are at present generally available. As already mentioned, sintered zirconia (without bonding material) is a promising material, but it is not one which can yet be produced easily. As mentioned in the discussion on Mr. Darling's paper, it is probable that fireclays much more refractory and durable than any yet known could be produced by more careful grading of the clay and "grog" employed, by casting instead of hand-moulding the pieces, and by devoting more care to the mechanical design with a view to securing uniformity of stress.

* Price 3s. 4d. net, post free, from ELECTRICITY Office.

TELEGRAPHY.*

Being Solutions to the Questions set by the City and Guilds of London Institute at the Final Grade Examination in Telegraphy held in May, 1922.

COMPILED BY A SILVER MEDALLIST.

(Continued from page 92.)

Q. 2.—Explain the function of the shunted condenser used in series with a high-speed Wheatstone receiver. Give a diagram.

A.—The speed at which the Wheatstone automatic system may be worked is limited, apart from line considerations, by the rate at which the receiver will record signals. This rate is limited because the self-induction of the coils of the electromagnets prevents the rapid magnetisation and demagnetisation of the cores. It is necessary to neutralise the effects of self-induction where a greater speed than 300 words per minute is required. This is done in practice by introducing a condenser shunted by a resistance into the circuit at the receiving end, as shown in Fig. 3.

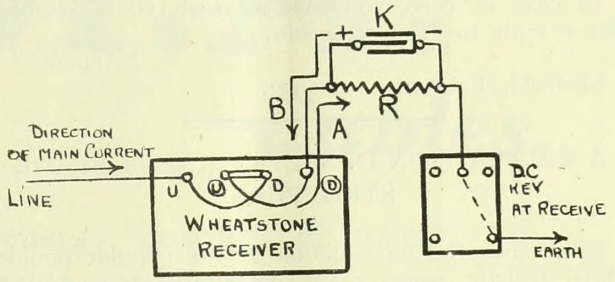


FIG. 3.

When the circuit is first made and the battery e.m.f. applied, the resulting current in the electromagnet of the receiver is increased above its permanent value by that required to charge the condenser and reduced by the self-induction of the coils. These two effects tend to balance each other and the current reaches its permanent value more quickly. Immediately the line current ceases the self-induction of the coils sets up an e.m.f., tending to prolong the current in the direction of the arrow *A*; the discharge from the condenser, however, is in the opposite direction, as indicated by the arrow *B*. By suitably adjusting the capacity *K* of the condenser and the resistance *R* of the shunt, it is possible to make these effects neutralise one another, in practice, and the break is thus made more sudden. The general rule adopted is to make $KR^2=L$ where L is the coefficient of self-induction of the receiver coils. This rule is only true, however, on the assumption that the resistance of the shunt is very high compared with that of the coils.

(To be continued.)

Finance.—A circular is being issued to the preference shareholders and noteholders of Fuller's United Electric Works, Ltd., inviting investment in 6 per cent. First Mortgage Debenture Stock, now being issued under the scheme of reorganisation which has been carefully prepared during the last few weeks. With a new and more vigorous board of directors and fresh funds, this good old firm should now be able to weather its difficulties and again take its share in the electrical trade, which we all think is showing quiet but really steady signs of improvement. Good luck to them.

* Consult also "Questions and Solutions in Telegraphy and Telephony," Final Grade, by Few, 2s. 3d. post free from ELECTRICITY Office.

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Correspondence.

UP-TO-DATE BILLIARD-TABLE LIGHTING.

To the Editor of Electricity.

Sir,—I was recently asked to give my opinion concerning some new billiard-table lighting, and I was glad of the excuse that I was not a billiard player, merely remarking that there seemed to be plenty of light; but I now wish to venture my opinion that foot-candles were too much in evidence, and that the cardboard shades were far from scientifically designed. I think the photometer would reveal a mottled illumination.

I should be glad if you or some of your correspondents could give me particulars of up-to-date billiard-table lighting. I thought of some type of industrial metal shades, also whether semi-direct or indirect has ever been utilised for the purpose, and whether a correctly curved or domed ceiling with an opaque reflector would be worth thinking of, also whether the usual six lights are better than five.

In case of correspondence through your columns, please reply to—Yours faithfully,

"Albedo."

Sheffield, February 20, 1923.

A REVOLUTION IN SAFETY RAZOR BLADE STROPPERS.

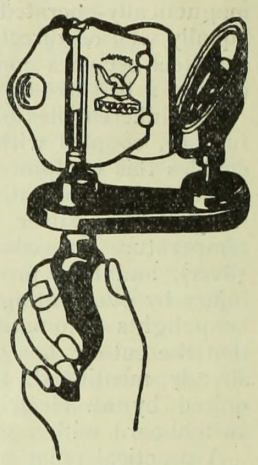
Ever since the introduction of the popular double-edged Gillette safety razor, inventors far and wide have busied themselves in an endeavour to produce a perfect stropper and honer for the thin but highly efficient cutting edges. Up to the present their efforts have been unsuccessful and the majority of these safety razor stropping devices are based on fundamentally wrong principles.

For reasons best known to themselves, but fairly obvious to everybody who considers the subject, the makers of the blades do not advocate resharpening, and state on their labels, and in fact on the blades themselves, "No stropping—no honing." This injunction, however, is contrary to accepted practice in connection with the maintenance of edged tools in constant use, and razor blades in particular.

No razor, whether ordinary solid, hollow ground, or safety, will retain its keen edge without regular attention, but there is no reason why judicious honing and regular stropping should have any more deleterious effect on a thin safety razor blade than on the old-fashioned variety.

Both implements are, or should be, of high quality hardened steel, and, whilst occasional honing may involve the actual removal of an infinitesimal quantity of steel from the cutting edge at each operation, and thus eventually reduce the effective width of the blade and its consequent projection and clearance above the toothed guard, stropping has no such result, but leaves the original finely serrated cutting edge unaffected, save that the microscopic serrations are again lined up by the stropping process after having been bent out of line by their passage through a strong beard.

Viewed under a powerful microscope a keen razor edge, in good condition, resembles the edge of a saw. The act of shaving gradually displaces these fine teeth, bending them to one side or the other, after the manner of "setting" the teeth of an actual saw to give it clearance. As already explained, the act of stropping resets these teeth in line, and the razor edge is again made as keen as before use, without, however, removing any metal in the process.



It follows that a good quality safety razor blade, efficiently stropped, should last just as long as an ordinary razor, and that there should be no necessity to scrap the blades after a week, ten days, or a fortnight's use, as is customary with many users of safety razors.

Some shavers spend a small fortune in new blades every year, whereas at the cost of a dozen blades they can procure a well-designed, thoroughly efficient and convenient stropper which will indefinitely prolong the life of a single blade, and, what is more, ensure a perfectly close, quick and easy shave every time the razor is used.

The "Tarantella" Stropper illustrated is designed to accommodate Gillette blades and, as shown in the illustration, is operated after the manner of a bird-scarer or policeman's rattle, being lightly whirled in the hand first in one direction, then in the other. This causes the oblique leather-faced strop to pass with a rotary motion, up and down the full edge of the blade and at an angle to it, thus imitating the expert barber's stroke on a conventional strop, but without his dexterity, arising from long practice, and with mechanical precision independent of the user or his inexperience.

Reversing the blade in the spring clip, and repeating the process, re-conditions the opposite edge, the entire process occupying a minute or even less. For obstinate cases, or blades in very bad initial condition, a carborundum honer is included in the set, and is interchangeable with the stropper, either being secured in place on the rotary spindle by a spring clip.

The "Tarantella" Stropper embodies all the best and accepted principles in razor blade sharpening, and is, moreover, well made. Each stropper is supplied complete in cardboard box, with a tin of paste and directions for use.

"Tarantella" Stroppers are obtainable at 5s. 6d. each, post free, from "Tarantella," 163, Moscow Drive Stoneycroft, Liverpool, to whom all communications should be addressed.

Meetings.—The annual general meeting of the British Electrical Development Association will be held at the Hotel Cecil, W.C., on Friday, 16th inst., at 12 noon, to be followed by the third annual luncheon. Tickets 12s. 6d., obtainable from the Association's offices, 15, Savoy Street, W.C. 2.——The second annual Costing Conference of the Inst. of Cost and Works Accountants will be held on the 9th inst. in the Connaught Rooms, Great Queen Street, W.C. The subject is "Standardisation in Costing." All interested in cost accountancy are invited, and tickets may be obtained from the Secretary of the Institute at 38, Grosvenor Gardens, S.W. 1.

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The Craigpark Electric Cable Co., Ltd.

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The Greengate & Irwell Rubber Co., Ltd.

W. T. Henley's Telegraph Works Co., Ltd.

The India-Rubber, Gutta-Percha & Telegraph Works Co., Ltd.

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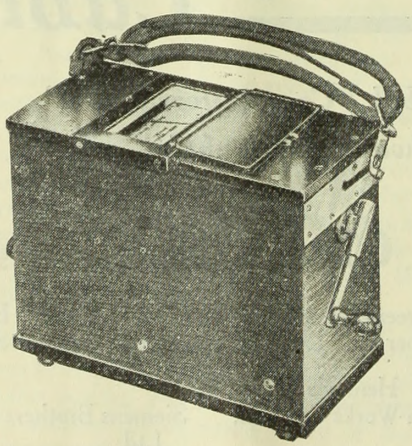
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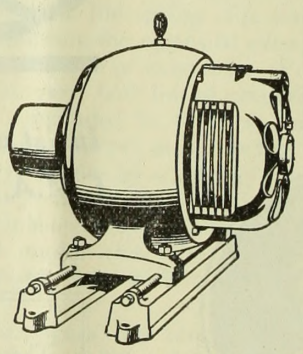
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Current Topics.

"Four (Blind) Mice—See How They Run," etc.

By a curious coincidence the Barrow electricity breakdown, so interestingly explained by Mr. Heslop in a recent issue, has been closely followed by a similar occurrence, having an almost precisely similar origin, at Lincoln Electricity Works, and, as at Barrow, causing a failure in the city's electricity supply of half an hour's duration. Strangely enough these two happenings also indicate prescience on the part of a certain gentleman in the electrical industry, who journeyed to Hamburg some time ago ostensibly to buy electrical gear, and ended up by buying—Mousetraps! I take the opportunity of complimenting him upon his foresight, and, should this paragraph catch his eye, perhaps he will favour the respective electrical engineers of Barrow and Lincoln with appropriate literature on the subject of "Little Nippers."

Joking apart, this makes two serious cases of electricity breakdown within two or three weeks, each caused by mice. At Lincoln, four of these tiny rodents, apparently acting in concert, entered the casing of a static transformer, and, bridging the 6,000-volt terminals with their tiny bodies, were instantaneously electrocuted, and, in fact incinerated, only their charred remains serving as evidence of the cause of the short circuit. Here we have another instance of the urgent necessity for so designing the casing and mounting of important electrical gear as to render it impervious to vermin. Mice can obtain entry through an incredibly small aperture, a fact which should not be lost sight of by the designers and manufacturers of electrical plant, and more especially high tension gear, since the risk of damage in the latter case is higher owing to the potentials involved and the correspondingly increased facility with which short circuits and other faults are initiated.

While on the subject it is of interest to review the cause of the Oldham catastrophe, reported in last week's issue. On Saturday morning, the 10th ult., the second 6,000 kw. set had been taken off load, and was being tested to ascertain if the over-speed trip gear was in working order, when, just at the point where this gear automatically operates (about 3,300 r.p.m.) the shaft of the alternator rotor broke, wrecking the alternator. Numerous pieces of metal were thrown all over the engine room. The driver and assistant driver on duty at the time were slightly injured, and it was remarkable that no one was killed. During the accident the lubricating oil overflowing from the main bearing caught fire due to friction heat. The fire brigade were called, and on arrival immediately put this fire out. Immediately following the mishap the entire plant was carefully examined, and normal supplies, including the usual Saturday tramways service, were resumed in about an hour's time. One imagines that there must have been a flaw of old standing in the broken shaft, but if the failure arose from "fatigue," it affords an opportunity of investigating whether this natural phenomenon is accelerated by the molecular vibration set up in most alternating plant, and which is a thing apart from the ordinary mechanical vibration, coinciding as it does with the periodicity of the supply.

Gas Poisoning—Is it to be Allowed to Continue?

Chairmen and managers of the leading gas companies have been assiduous of late in their well-meant endeavours to allay public suspicion regarding the characteristics of the gas supplied by their respective companies. It has been emphatically stated that there has been no change in the quality or constitution of the gas supplied to the public for the past ten years or more; that the percentage of fatalities directly traceable to gas is a very small percentage compared with those due to street accidents and other causes; that the reduction of the permitted percentage of deadly carbon monoxide now present would inevitably cause gas to be dearer, and various other specious arguments in favour of *laissez faire* have been advanced. Failing a show of interest by the Board of Trade, which really ought to have investigated this menace to public safety some time ago, when the trouble was first evidencing itself, a question has at last been asked on the floor of the House, and now, presumably, action will be taken at last.

The danger to the community of the growing use of carbon monoxide, an odourless, deadly poison, in or by domestic gas, was drawn attention to by Mr. Percy Harris. He recalled that the change in the composition of coal gas arose from the extended use of water gas in its manufacture. Blue water gas contained 42 per cent. of carbon monoxide, "one of the most deadly poisons and also odourless and colourless." The explanation of the use of water gas was that it made the gas cheaper, and also allowed the extraction of more by-products from the gas. At an inquiry by a Departmental Committee held in 1920, evidence was given that in towns where water gas was used the fatal accidents from gas poisoning were two and a-half times as high as in towns in which none was used. The committee, he said, recognised the risk of this deadly poison, but they declined to recommend any limitation of the percentage of carbon monoxide in coal gas on account of the economical advantages arising. He alluded to the fatal cases of death from gas poisoning, and called for another inquiry, especially as to whether gas mains were equal to the strain of modern road traffic. The President of the Board of Trade promised to submit a report on the subject, which is now in course of preparation; but it would appear that vested interests bulk largely in this controversy, and the advocates of public health *versus* private gain are likely to face a stiff opposition to any projected change or legislation on the subject.

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'Appy 'Ampstead.

Thanks to the introduction of bulk supply considerable economies have been effected in the working and capital costs of public electricity supply in Hampstead. As a result, the Lighting Committee has recommended to the Hampstead Borough Council that the cost of electric light, power, and heat be correspondingly reduced from 7d. to 5d. and from 2d. to 1¼d. per unit respectively. Hampstead is doubly fortunate in that her local ratepayers are protected against municipal profiteering by a statutory limitation of the amount which may be accumulated in reserve to 10 per cent. of the capital outlay. There is thus no alternative on the resultant financial economies but to reduce the charges for electricity, or transfer extra profits to the relief of the rates generally. It is, fortunately, probable, Hampstead councillors being sane business men, that the benefits will be directly passed on to those who are most justly entitled to them, viz., the actual consumers. Hampstead now receives its supply in bulk from the Marylebone generating station.

Electric Power for Textile Mills.

For years there has raged a controversy over the respective suitabilities of steam and electric driving for cotton and other textile mills, the old conventional method of driving such mills by a steam engine or engines still finding many firm and conservative supporters. In the light of the evidence given at the inquiry by the Electrical Commissioners into schemes for an improved supply of electricity in Mid and East Lancashire, however, there is every likelihood, if the electrical plant manufacturers and contractors follow up their advantage, and strike while the iron is hot, that many converts will be made to electric driving. At the resumed sitting, held at Preston last week, Mr. William Birtwistle, who remarked that he was afraid he would have to plead guilty to being the largest cotton manufacturer in Lancashire, said that his mills were driven partly by steam and partly by electricity.

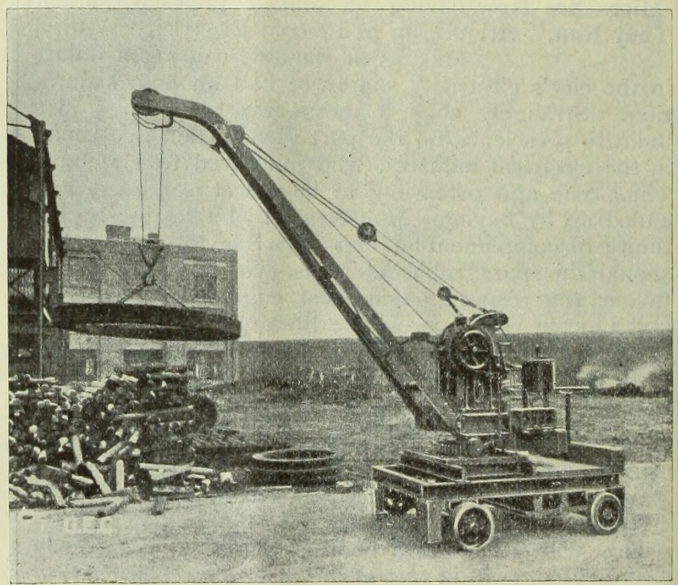
His experience told him, however, that electricity had many advantages over steam. While with steam the speed varied, with electric driving the highest speed could be maintained. He had found in some cases that with electricity they were getting the same results with a 48-hour week as they previously obtained with 55½ hours under steam power. Here, indeed, is an unsolicited testimonial to the advantages of electrification from one of the largest Lancashire mill-owners; and, if the trade does not take full advantage of it to convince the waverers whom they have been endeavouring to convert to modern methods for the past decade, then all I can say is they don't deserve to secure the contracts. Admittedly, the cotton trade is not in the best of conditions financially at the moment; but Lancashire men are hard-headed, and it should not be difficult to convince them that a considerably larger output in the same or less time constitutes a paying investment. There should be some cheap second-hand mill engines on offer up North before many months are over.

Elektron.

WITTON-KRAMER ELECTRIC TRUCK CRANES.

In every works and warehouse there are always instances arising of loads which have to be lifted and transported from positions that cannot be reached by any of the ordinary hoisting appliances. The steam or electric yard crane is generally limited in its radius of operation by the tracks on which it travels, and these usually serve only main arteries, whereas overhead cranes and runways are usually confined to the shops.

The electric truck has solved the difficulty of power transport between remote points, and a further development is the electric truck crane—built not as an accessory to the truck but designed throughout as an electric travelling crane. With a machine of this description loads, wherever they may be, can be picked up and deposited and the crane can be moved rapidly to any spot where a sudden necessity arises for a load to be handled quickly.



The "Witton-Kramer" crane illustrated is of the two-motor type, one motor being used for propelling the crane the other to operate the hoisting, slewing and derricking motions, clutches being utilised to transfer the drive to the desired motion.

The crane is capable of lifting a load of one ton at a radius of 10 ft. and at a speed of 20 ft. per minute. It slews at 3 r.p.m. and travels at 4 m.p.h. The arrangement is such that all motions, including travelling, can be operated from the driver's platform with the jib directly in the line of travel.

Electric or mechanical brakes are fitted to all motions. The battery is built into the truck and is of sufficient capacity to supply the crane for six hours without recharging.

Sheffield.—The D.P. Battery Co., Ltd., have received an order from the Sheffield Corpn. Cleansing Dept. for one of their Kathanode electric vehicle batteries for use on one of the latter's vehicles. The batteries have proved most satisfactory, and many repeat orders are being received.

Germany.—According to the British Commercial Attaché in Berlin, in the electro-technical industry Frankfort reports good sales during January, while in Berlin there was a weak demand for motors, calculators, apparatus, small manufactures and wires. Only the turnover in high-pressure current cable improved.

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"WIRED WIRELESS"—LINE RADIO.*

BY MAJOR J. A. MAUBORGNE, UNITED STATES SIGNAL CORPS.

(Continued from page 53.)

In the preliminary experiments previously mentioned, and in the earlier New York Central tests, one overhead wire with a ground return was employed. A comparison of this arrangement with an all-metallic circuit showed that the latter was the much superior of the two, both as to volume of speech received and the elimination of external disturbances such as that produced by nearby radio stations. The reason for this improvement is attributable to the pronounced energy-radiating and absorbing properties possessed by the one elevated wire with ground return.

The question of cross-talk was investigated, as it was believed that at the high frequencies inter-line disturbances might be prohibitive of utilising the same carrier frequency on more than one line or pair of lines on the same pole. In the Washington-Baltimore tests it was found that it was possible to receive signals with the lead wire to the receiving apparatus disconnected from the line in question and held in the immediate vicinity of the same or wrapped around, but not making contact therewith. Signals of reduced intensity also were received with a lead wire connected to other immediately adjacent lines on the same cross arm.

Complete elemination of cross-talk to other lines, however, was obtained when the first few miles of conductor adjacent to the transmitting apparatus ran through underground cable. When employing an entire metallic circuit, at the very highest frequencies used, there was a complete absence of cross-talk to the other conductor pairs on the same pole.

The problem of multiplexing the lines has been given some study by the Signal Corps, but no definite data is available for presentation at this time. The construction of the various carrier frequencies to be used in multiplexing is roughly determined by the condition that each band of wave lengths needed for transmission shall be 5,000 cycles in width, and that these bands shall not overlap; but the problem is more complicated than this mere statement would imply, since the matter of harmonics and other points also must be considered in the selection of waves for multiplex working.

It is evident that for successful operation wired wireless telephone systems must be capable of being worked in either direction without switching. This is made possible by using a different carrier frequency in each direction or by using the same frequency and a bridge arrangement. The latter is a much more difficult method, but allows of more channels. A discussion of this arrangement cannot be entered into at this time, but can be found in the bibliography of the art referred to.

Referring again to the subject of "filters," about which much has been written, we will state briefly that the "filter" is arranged to pass a band of frequencies of a certain width. Usually this band of frequencies is 2,000 per second wide, and the "filter" must pass this band with a very small attenuation, and offer a large attenuation to all frequencies outside this range. Fig. 5 shows a "filter" chain consisting of inductances and capacities, designed by Campbell, which will pass low-frequency currents and Fig. 6 one which will pass high-frequency currents. Two such chains in series will give the required characteristic shown in Fig. 7.

Another arrangement, Fig. 8, is due to K. W. Wagner, which gives a curve similar to that shown in Fig. 7, and the band can be made of the correct

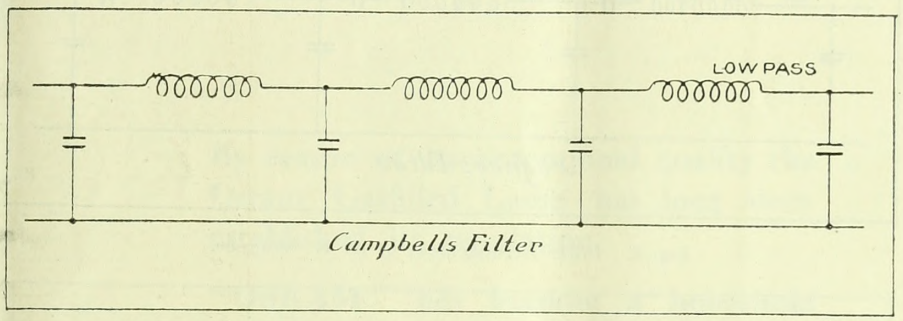


Fig. 5. "Filter" Chain Which Will Pass Low-Frequency Currents.

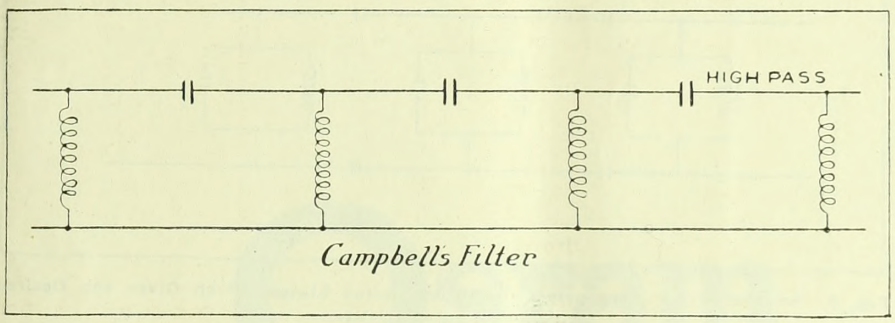


Fig. 6. "Filter" Circuit Which Will Pass High-Frequency Currents.

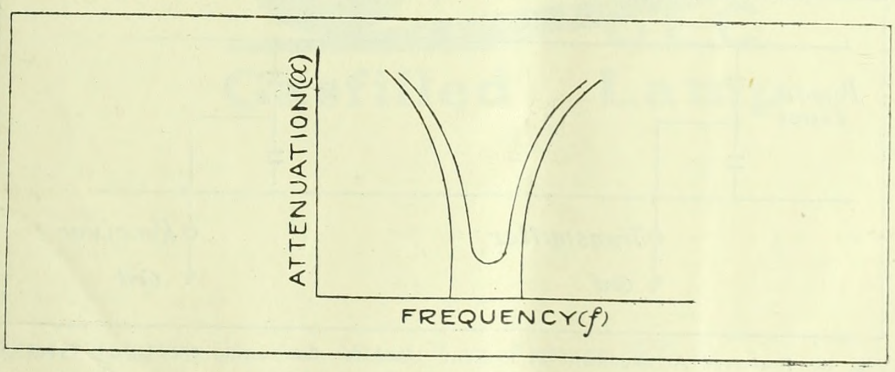


Fig. 7. Characteristic Curve from Combination of High and Low-Frequency Filters.

* *Telephony* Chicago.

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width, and for the actual frequencies desired by a suitable choice of the inductances and capacities. Still another "filter" arrangement used in this country also giving the desired band characteristic is shown in Fig. 9.

For a very complete exposition of the theory of these "filters" it is recommended that K. W. Wagner's article in the "Archiv fur Electrotecnick," Volume 3, 1915, be consulted.

Much might be said about the harmonic generator and balancing network arrangements employed by the American Telephone and Telegraph Co. in this country, but time will not permit of the introduction of this matter. A careful study of this can be made by those interested by consulting the paper of Colpitts and Blackwell before referred to. Likewise arrangements for transmission of wired wireless over high-tension power lines cannot be dwelt upon here, but must be found in the literature on the subject. It is believed, however, that a brief reference to the method of wired wireless broadcasting over power and light lines may well be touched upon at this time.

Some time during the months of March and April of last year Major-General Squier made an announcement of the work which had been done in the office of the Chief Signal Officer in connection with the subject of broadcasting on light lines, upon which General Squier has applied for patents in connection with his earlier patents on the broad general subject of wired wireless.

These experiments have demonstrated that it is entirely feasible and practical to transmit high-frequency current telephony over power lines and electric light circuits, and to receive it at any point on the line. A signal transmitter with an output of not over 50 watts connected to the power or lighting lines of a city at some suitable point may broadcast over a considerable area and may be received by a great number of people by connecting ordinary radio receivers at various points on the line, the connection usually being made by a suitable plug placed in any lamp socket.

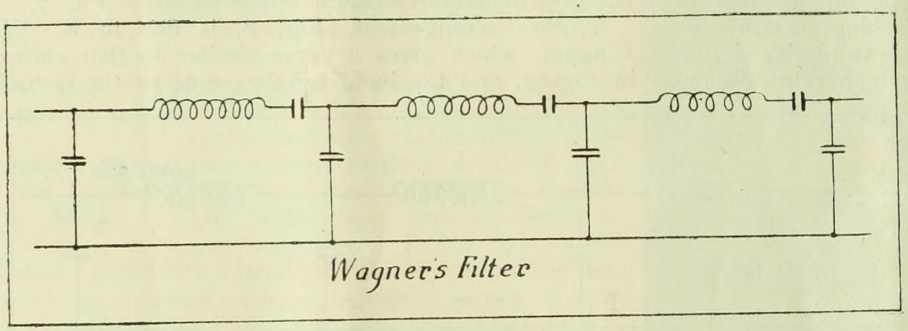


Fig. 8. Filter Arrangement of K. W. Wagner.

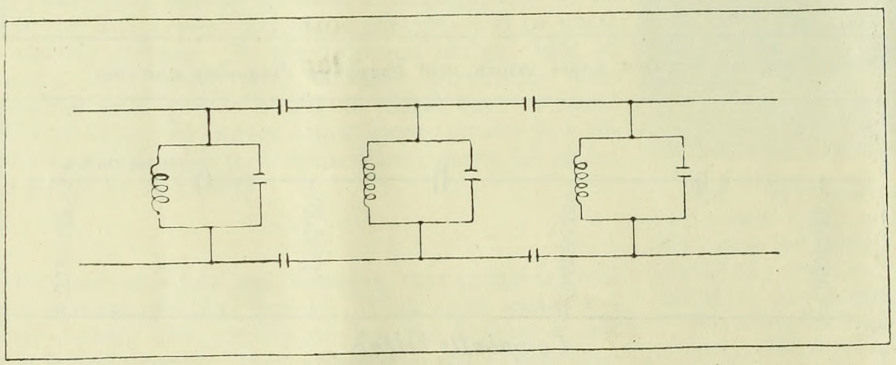


Fig. 9. Another Filter Arrangement Used in United States Which Gives the Desired Band Characteristic.

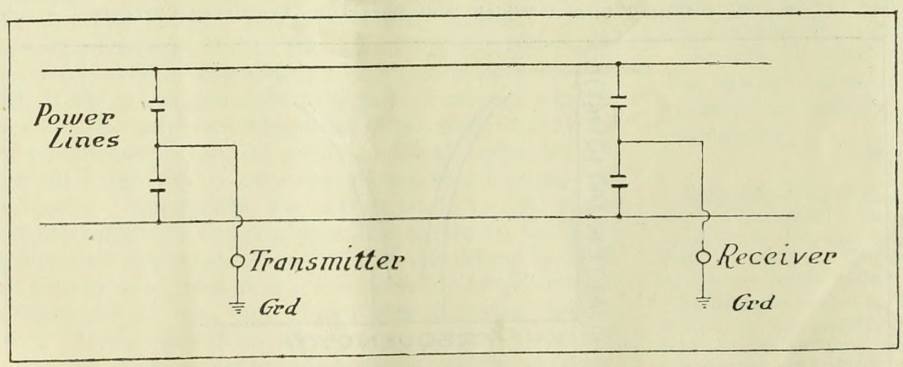


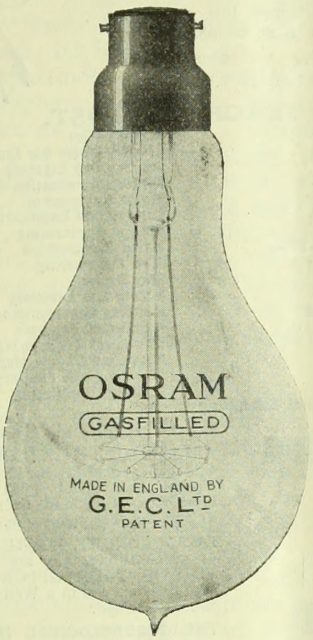
Fig. 10. Preferred Arrangement at Present Used for Connecting the Usual Types of Radio Apparatus to Power Lines.

The transmitters and receivers are of usual types now employed for radio telephony, and may be connected to the power line in various ways; the preferred arrangement being used at present is shown in Fig. 10.

In this method of connection the danger of short-circuiting the mains is entirely avoided—the condenser between the mains acting as a by-pass for the high-frequency currents only, but allowing the low-frequency power current to flow along the mains. For the radio currents the two mains are connected in parallel and used as one conductor, the ground being the return conductor.

It is to be noted, however, as before mentioned, that there is a tendency for the lines in this case to radiate because of the relation of the line to the ground. Hence material broadcast on electric light lines in this way, particularly if the lines pass out from underground conduit and become overhead wires, may be received by an ordinary antenna entirely disconnected from the lighting circuit. Better results with practically no radiation from the lines are obtained by connecting the transmitters and receivers between the mains instead of to ground, the mains being suitably protected by condensers to keep the large power current from passing through the radio apparatus. In addition to the condensers shown in Fig. 10, the receiving set itself should

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have a variable air condenser in series with the tuning inductance of the primary circuit for the purpose of tuning the line.

(To be continued.)

BRITISH INDUSTRIES FAIR.

The British Industries Fair, Birmingham Section, opened its fourth exhibition at Castle Bromwich, near Birmingham, on February 19.

The Department of Overseas Trade, together with the Birmingham Committee, are to be congratulated on the success of the show. Despite the many disappointments of the past few years, local manufacturers are showing as strongly as ever, although there is an absence of some of the large associated stands which were a feature of some of the earlier exhibitions. It is possible that the manufacturers' associations are economising their efforts for Wembley next year. The electrical firms are not so well represented as they should be, and the electrical exhibits show a marked decrease over previous years.

Messrs. J. H. Tucker and Co., Ltd., as usual, have a large stand which gives an excellent idea of the wonderful range of their manufactures, including an extraordinary number of varieties of their well-known tumbler switches. One of the most interesting features of this stand is a large model of the new quick make and break tumbler switch, which, by virtue of its size, demonstrates its many qualities on a scale large enough to examine in detail. There are also many fine examples of switchboards and the Tucker range of ironclad gear. Within the range of a short notice it would be impossible to do justice to the many items this versatile firm show, and which fully maintain their reputation for fine workmanship in every line touched by them.

The Cable Accessories Co., Ltd.—The "Revo" range of electrical and other products is shown on a large stand near the exhibition entrance. There are "Revo" lighting fittings, watertight and otherwise, including the lantern specially designed for the lighting of Princes Street, Edinburgh. On the same stand is shown the firm's crystal receiving set, electric fires, irons, ironclad switch gear, and the whole range of electrical accessories for which this firm are becoming famous.

Automatic and Electric Furnaces, Ltd.—This is another stand of great interest to electricians. The "Wild-Barfield" furnace is shown in actual operation, and Mr. Barfield appeared to be having a busy time. If the amount of interest shown in this furnace is any measure of the business being done, the firm is likely to be very busy.

Accles and Shelvoke, Ltd., are showing their range of small motors from 1/10th to ½ h.p., together with electrically driven water pumps, tyre inflators and other apparatus to which small motors can be readily applied. A specially interesting exhibit on this stand is a self-contained battery charging board for use in garages and similar situations. It appears to be a remarkably neat and effective piece of apparatus.

The Premier Electric Heating Co. show on their stand a full range of their highly-finished electric heating and cooking apparatus. This firm well maintain their reputation for excellent design and high finish. Their kettles, toasters, irons, and bowl fires are equal in appearance to any of the American types, and in point of design, accessibility of elements, etc., far superior to most of them.

The Park Royal Engineering Works, Ltd., show electrical switch gear with truck type cubicles, circuit breakers, self-aligning fuses, etc., all of the high standard usually associated with this firm's work.

Edison and Swan, Ltd., have a stand upon which "Fullolite" lamps make a brave show. A large number of their other specialities are also exhibited.

Sturge and Baker show their ingenious cord absorber. This excellent fitting enables any pendant to be arranged for rise and fall at the smallest possible cost, and is made in every convenient size. They also show electric fires of many types, together with a range of tumbler switches without exposed metal parts.

Joseph Steer, Birmingham, exhibit the "Bradwell Tester," which is a motor-car electrical testing device invented by Mr. Joseph Bradwell, M.I.E.E. It is described as a "consultant on the dashboard." It is much more convenient and is certainly more complete than many of the much advertised devices for plug testing.

Venner Time Switches, Ltd., show time controlled mechanism of all descriptions, especially time switches for shop window lighting, and many other devices in a field which this firm have made peculiarly their own.

Soutter and Sons are the only firm this year exhibiting decorative electric light fittings. They show an excellent range.

Edison Accumulators, Ltd., have a stand upon which is shown a complete set of their all-steel accumulators varying in capacity from 1.5 to 45 ampere hours.

The visit of the Duke of York to the exhibition on Thursday, February 22, was a social event of considerable interest. We understand that H.R.H. took a great interest in much of the electrical apparatus shown.

Questions and Answers by Practical Men.

RULES.

QUESTIONS: *We invite our readers to send us questions, preferably on technical problems that have arisen in actual practice. Questions which we consider of sufficient interest to our readers will either be replied to under "Answers to Correspondents" or replies will be invited from our readers. One shilling will be paid for the question which we select for competitive replies in this column.*

ANSWERS: *A fee of 10s. will be paid for the answer which we consider shows the greatest merit, and 5s. for the one we select as second best. In judging the replies, importance will be attached to clearness and conciseness, as well as accuracy. The Editor reserves the right to make no award, or to accept only one reply, if, in his opinion, the answers received do not possess sufficient merit. Competitors desiring the return of their manuscripts, if unaccepted, should enclose stamped addressed envelope.*

Write on one side of the paper only, and if diagrams are sent, draw them on a separate sheet of paper attached to the manuscript. Competitors may adopt a "nom de plume," but, both in the case of questions and answers, the competitor's real name and address must be sent with the manuscript as a guarantee of good faith. No correspondence will be entered into with regard to successful replies. The Editor's decision is final.

Commencing with Question No. 101, a Diploma of Merit will be awarded to the six competitors who win the first or second prize the most times during the next twelve months.

The words "Questions and Answers" or "Q" and "A" should be placed at the top left-hand corner of all letters intended for this column.

QUESTION No. 155.

Can anyone give me details which govern the selection of a fuse carrier? I desire some for use on the following service:—Volts 440 d.c., 50 amperes, three wire.—"Cable."

QUESTION No. 156.

Can any reader give me information concerning a good method of indirect lighting. I have a small study where I do a lot of drawing, and I find the ordinary electric light is very trying for my eyes.—"Pen."

(Replies to Questions 155 and 156 must be received not later than March 31, 1923.)

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ESPRIT DE CORPS.

At the meeting of the Informal Section of the I.E.E., on the 19th ult., Mr. F. E. Hetherington was in the chair when Mr. F. Peake Sexton opened a discussion on "Esprit de Corps." The opener traced the genesis of "Team Spirit" and class interest, and said that he thought that the lack of patriotism and national feeling in individuals was very often because they had failed to appreciate or had jumped over the stages, the family ties, professional prestige and national pride, to a universal brotherhood idealism.

Other trades and professions had developed from the old trade guilds and have inherent the esprit de corps that is almost non-existent in the electrical industry.

He instanced cases of members of the industry abusing to a third party the advice or craftsmanship of another electrical man—he read an extract from a letter written by a borough electrical engineer to the effect that within his district "we do not recognise the rules of the Institution of Electrical Engineers, but have our own regulations, etc."—a quite illegal attitude, by the by, if made a condition for connecting an installation—and he compared the conditions prevailing in our industry with those of the medical and legal professions, where etiquette is so powerful.

He could not propose a remedy, and appealed for more pride in our industry and in membership of the Institution and for more care in criticising the operations of fellow engineers.

Major G. H. Spittle led the discussion with a humorous speech describing regimental and corps pride, upon which military discipline is fostered.

Messrs. J. R. Bedford, J. Coxon, A. G. Hilling, E. F. Hetherington, H. H. Long, W. Lunn, F. Pooley, W. E. Rogers, M. Whitgift and W. L. Wreford also spoke.

Various Items.

Llandrindod Wells.—The U.D.C. will probably take over the electricity undertaking at the beginning of the next financial year.

Removal.—Mr. M. W. Woods, electrical engineer, states that his London offices have been moved to 15-16, Railway Approach, London Bridge, S.E. 1. Tele.: Hop 6156.

Extension of Automatic Telephones.—Automatic exchanges are in use at Fleetwood, Blackburn and Accrington, and new groups suggested are Preston, Southport and Burnley. At Preston, however, it is considered the present switchboard is sufficient.

Belfast and County Down Rly.—In connection with the big power schemes in the North of Ireland, the possible electrification of this railway, which connects Belfast with Bangor, Newcastle, Donaghadee and other pleasant watering places, is foreshadowed.

Tenders.—The P.M.G.'s Dept., Melbourne, invite tenders for telephones and hand sets.——The P.M.G.'s Dept., Melbourne, invite tenders for switchboard cable.——The P.M.G.'s Dept., Melbourne, invite tenders for underground and submarine cables. Specifications, etc., at the D.O.T. (Room 49), 35, Old Queen Street, S.W. 1.

Meetings.—The Junior Inst. of Engineers will meet at 39, Victoria St., S.W. 1, on Friday, 2nd inst. Lecturette, "Glass-forming Machines," by C. Saxton (slides). Also on Friday, 9th inst., ordinary meeting. Paper, "Rolling-mill Machinery," by R. C. D. Fell (slides). On Friday, 16th inst., Lecturette, "Comparative Power Costs," by C. H. Woodfield, and on Friday, 23rd inst., Lecturette, "History and Development of the Underground Railway," by R. J. Siddall (slides). All at 7.30 p.m.——There will be a Wireless Section meeting of the I.E.E. in the Lecture Theatre of the Institution on Wednesday, the 7th inst., at 6 p.m. "Development of Naval High-power Valves," by H. Morris-Airey, C.B.E.

Customers Wanted.—An advertiser in the prepaid columns wishes to dispose of a small arc lamp, and another is pushing the sale of ball-bearing oil and gas engines at greatly reduced prices, which are certain to interest many readers.

Finance.—As usual, we have pleasure in congratulating the shareholders of W. T. Henley's Telegraph Works Co. on the very satisfactory report of the directors for the year 1922. After paying a dividend equivalent to 3s. per annum on the ordinary shares (15 per cent.), a balance of over £323,000 is carried forward to the next year's account.——The annual report of the Met. E.S. Co. for the year 1922 is a very satisfactory document. The total dividend is equal to 8½ per cent. per annum on the ordinary shares.——The directors of the Electrical Distribution of Yorkshire, Ltd., recommend a dividend on the ordinary shares of 7 per cent. per annum, free of income tax.

Annual Dinners.—The No. 4 Company London Electrical Engineers will hold their annual dinner at Florence Restaurant, Rupert Street, London, W., on Saturday, March 10, at 7 p.m. Any members of the company who have not yet received a notice are asked to communicate at once with Mr. E. Beech at the "Metal Works," Shawfield Street, Chelsea, S.W. 3.——*Re* the Ex British-Westinghouse Association annual dinner, we are asked to remind interested readers that this gathering of genial Ex British-Westinghouse men will take place on Friday, March 9, at the Holborn Restaurant, London, and that there is still time to secure seats. Mr. A. R. Dyer, Chief Officer, London Fire Brigade, will preside, and those who have not yet obtained tickets should immediately write the Hon. Sec., Mr. L. S. Richardson, 14, Sydney Road, Richmond.

Trade Notes.

The Cambridge and Paul Instrument Co., Ltd., are issuing a card-circular describing and illustrating their latest types of Index Thermometers and Thermographs.

New catalogues in French, Danish and Spanish are being issued by **Automatic and Electric Furnaces, Ltd.**, of 173, Farringdon Road, E.C.1. They give details of the latest types of Wild-Barfield Electric Furnace.

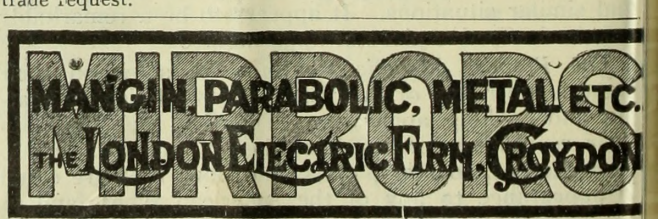
A well-printed folder, just issued by the **B.T.-H. Co., Ltd.**, gives illustrations and prices of an excellent range of glass shades for electric lamps. It will be of interest to all contractors and retailers, and can be supplied overprinted with any suitable name and address as required.

Circulars have reached us dealing with "The E.M.F. Electrical Year Book," which is an annual trade directory of the American electrical industry, and "The Jobbers' Salesman," a monthly journal for electrical business men, both of which are represented in this country by **Mr. Frank Watton**, of 16, Albert Street, N.W. 1. He will be pleased to supply further information on request.

The February price-list of electrical accessories has just recently been issued by **Messrs. Henderson and Thornton, Ltd.**, of 3, Percy Street, Tottenham Court Road, London, W.1. It contains details of electrical appliances which are likely to be of interest to contractors and installation engineers generally.

Messrs. Brook, Hirst and Co., Ltd., the well-known electrical switchgear manufacturers, of Northgate Electrical Works, Chester, announce that the name of the company has now been changed to **Brookhirst Switchgear, Ltd.** This, however, will not involve any alteration in the actual business of the undertaking, which will be carried on as before, save that there will be further developments in regard to actual manufactures.

An excellent catalogue of electric-light fittings, reflectors, standards, pendants, etc., has just been issued by **Messrs. Smith and Answell, Ltd.**, 109, Great Hampton Row, Birmingham, who manufacture architectural metal work generally. It should prove of direct value to all electrical factors and contractors, and the title page has been neatly perforated, so that it can be used by trade clients for circulation among private customers. It is well worth applying for, and will be sent on receipt of trade request.



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A POPULAR SCIENTIFIC WEEKLY JOURNAL
ELECTRICITY
A PRACTICAL TRADE JOURNAL

MARCH 9, 1923.

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THE NEW G.E.C. RESEARCH LABORATORIES.

Wembley is rapidly becoming a very important place. For instance, next year it is to see the inauguration of the colossal British Empire Exhibition, with its huge stadium which is to be opened very shortly, as most people know. Further, the transit facilities and other advantages of the district led the directors of the General Electric Co., Ltd., some time ago to build there new factories and a most important research laboratory, which was officially opened by the Rt. Hon. Lord Robert Cecil, K.C., M.P., and Sir Joseph Thomson, O.M., F.R.S., on the 27th ult., in the presence of close on 1,000 distinguished visitors.

The laboratories are a notable advance on any similar undertaking in this or any other country, on account of the general arrangement and magnitude of the scale on which operations are carried on—as will appear later, though if we were to deal in adequate detail with what is being done we should fill several issues of this journal.

Situation.

The laboratories are close to North Wembley Station on the extension of the Bakerloo Railway (Euston-Watford line), thirty-five minutes from Charing Cross and twenty-five minutes from Euston. Wembley Park Station, on the Metropolitan Railway from Baker Street to Harrow, is twenty minutes' walk away.

Buildings.

In considering the general laboratory design, no restrictions were imposed by shortage of ground space, and it was decided to adopt the "one floor" style of building rather than the multi-story type.

The building (Fig. 1) is mainly of red brick. It has a frontage of 400 ft. and a total floor area of 80,000 sq. ft., occupying an enclosure of four acres.

The "Weaver" shed type of north light roof has been mostly used, but a two-story central extension to the south forms the administration section. This form of construction gives opportunity for extension at five different points, so that in future any branch of research work can be supplied with additional accommodation without disorganising the scheme of the internal laboratory arrangements.

Lay-out.

There are nine small groups of rooms built out as private offices from the main laboratories, and arranged so that there is direct access from every laboratory to one or another of the groups of offices. Each research man thus has a personal sanctum near to his experimental work.

One of the guiding principles in the design of the building has been to provide ample accommodation and flexibility for the electrical and other services, such as gas, vacuum, compressed air, etc. It is essential for special experimental work to ensure that such services are easily accessible to any room and are available at any point in a room. Ample and well-lighted storage space for lumber and apparatus not in use is also most important; otherwise the laboratories become congested with a quantity of gear which is not in use.

Between the main laboratories on each side is a centre bay running the whole length of the building. This contains a corridor on the ground floor, and

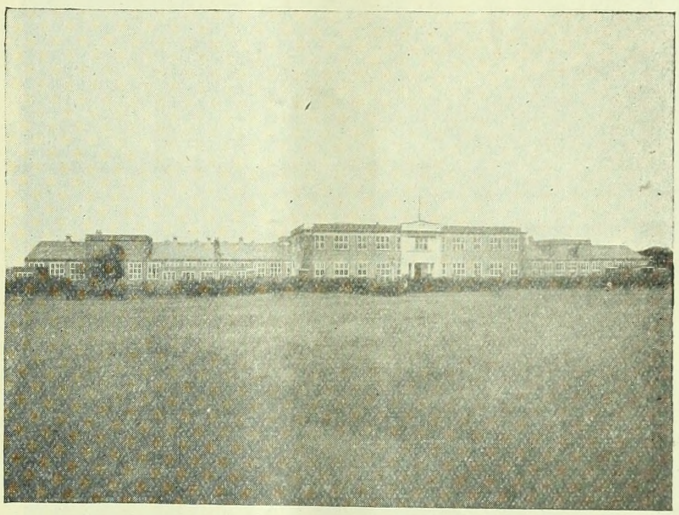


FIG. 1.—GENERAL VIEW OF THE G.E.C. RESEARCH LABORATORIES.

above the corridor a gallery, along the whole length of which run the pipe services and also the cables for the various electric supplies. This gallery also serves to accommodate the lumber and bulky apparatus not in use, as well as all general service apparatus such as compressed-air reservoirs, gas and water containers, hot-water apparatus, motors driving shafting, and all those things for which it is very difficult to find accommodation in a laboratory and which are not wanted in the experimental rooms themselves.

In nearly all the rooms on the premises the floors are of concrete covered with Marbello jointless flooring. The walls of nearly all the experimental rooms are plastered, and have fixed to them a framework of wood backing, to which temporary or permanent fixings can be attached without plugging the walls themselves.

The administration block is an ordinary two-story structure with reinforced concrete floor. It contains,

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besides the spacious hall and waiting-room, the library, store and packing-rooms, correspondence and other offices, and the research staff refectory.

Lighting.

The useful height of all rooms from floor to underside of roof is 14 feet. The importance of artificial illumination in the experimental rooms has been diminished by the provision of very good natural lighting. Being out of the range of London fogs, artificial light is needed for a relatively few hours in the year only. For the north-lighted rooms the sloping ceilings are of smooth whitened plaster slabs, and the reflecting surfaces of these are utilised for spreading general diffused light from open high candle-power frosted units placed well up in the ceilings.

Equipment.

Apart from the special apparatus in individual rooms, there is general equipment which includes various services, electric and piping, which have to be distributed throughout the building. The general arrangement for making the supplies available in any laboratory is to bring the pipes down at the centre of the room to within 6 ft. 6 in. of the floor. Two gas and two compressed-air pipes come down at the four corners of a rectangle measuring about 6 ft. by 3 ft., and to their lower ends is attached a timber framework which braces it together and forms a kind of cradle, clear of a man's head, but yet accessible for manipulating taps and terminals. The other pipe supplies are brought down to the same level (see Figs. 2, 3 and 4).

On this cradle are terminated all supplies—piping or electric—and connections are easily made to them from experimental tables and benches disposed suitably about the floor area below.

The taps and nozzles of the pipe supplies on the cradles are different for each supply both in colour and form, in order that confusion may be avoided between the different supplies.

Electrical Supplies and Distribution.

The various electric systems in the laboratories divide themselves into two groups—permanent and experimental. The whole of the lighting system is permanent and is not touched for experimental purposes, and so are all the charging feeders and main supplies to the various switchboards.

There are two ring mains round the walls of every room—110 volts A.C. and 110 volts D.C.—which terminate at plug points on the wall, and also on the cradles. The wiring is all permanent, and is not tampered with for experimental connections as far as these sockets and up to the circuit terminals on the cradles. All feeders and wiring, up to their termination on the cradles or up to the wall sockets are under the charge of the laboratory maintenance staff. Beyond these points all circuits are temporary and under the control of the research people.

Three main control points are provided, with seven distribution boards for experimental electic circuits used by the research workers. These points are at the three junctions of the three wing corridors with the main corridor, where are situated switchboards enabling any of the different sources of electric supply to be connected through to any laboratory. Each switchboard, of which there are seven, consists of four parts:—

(a) A panel for one battery with some 20 sets of sockets connected to tappings for different voltages.

(b) A panel with sets of sockets for connecting to all the other electric supply voltages A.C. and D.C. in the laboratory.

(c) A panel with sockets which are the terminations of inter-connecting mains to every other similar distribution board in the building.

(d) A panel with sockets terminating the cables which run into those laboratory rooms which the board in question is specially designed to serve.

Connections from the sockets on these last panels to

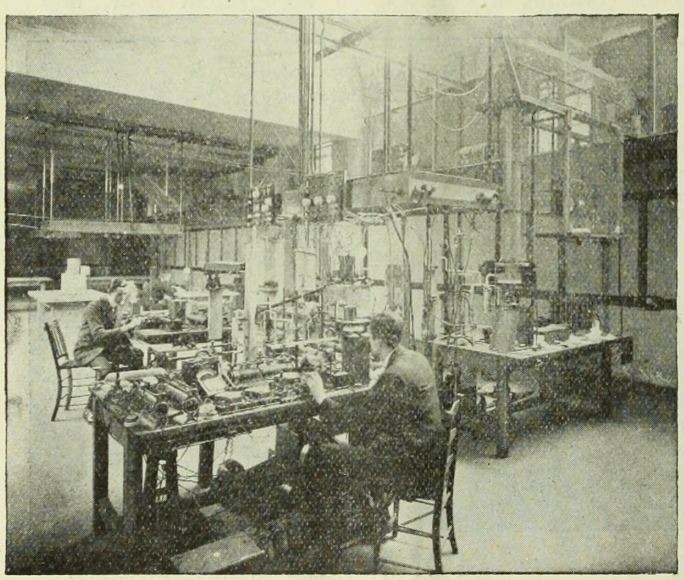


Fig. 2.—The Vacuum-Physics Laboratories.

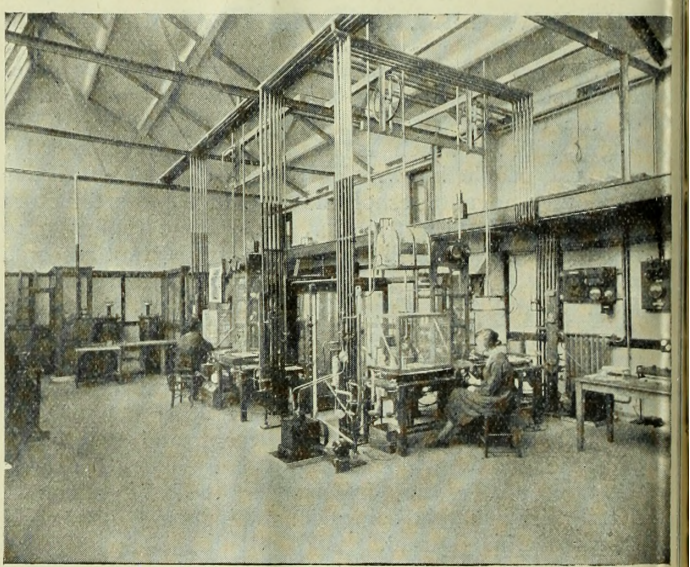


Fig. 3.—The Valve Laboratory-Factory.

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those of any of the first three supply panels are made by flexible cables and plugs. Two sizes of plugs and cables are standard, one for 100 amps. and one for 15 amps. The arrangement is very flexible, and is a fuller application of the system installed in the Electrotechnics Department of the National Physical Laboratory. The advantage of making every electric supply in the building permanently available at every distribution board is obvious, and soon pays for the cost by the saving of time.

The supplies which are thus made available are the following :—

415 volts 3-phase 4-wire district supply (240 volts to neutral).
110 volts D.C. machine with Tirrill regulator.
110 volts A.C. 3-phase 4-wire from transformers.
415 volts A.C. single-phase lamp life test supply with Tirrill regulator.
150-0-150 D.C. lamp life test supply.
0-75 volts motor booster (voltage adjustable).
110/451 volts D.C.-A.C. motor generator.
110 volts battery (600 amp. hour) sub-divided.
360 volt battery (180 amp. hour) sub-divided.



FIG. 4.—ROUTINE LIFE TESTING OF LAMPS.

360 volt battery (50 amp. hour) sub-divided.
360 volt battery (22 amp. hour) sub-divided.
110 volt battery (180 amp. hour) sub-divided.
80 volt battery (180 amp. hour) sub-divided.

Larger currents or higher voltages than are available from the above supplies are usually required for special purposes only and are arranged for specially at the point of use.

The greater part of the electrical gear and fittings are the product of the various works of the General Electric Co., Ltd.

THE LABORATORY-FACTORY.

Most factories have laboratories, but the plan of laboratories having factories within them is less generally adopted. It is naturally not possible for all types of products, but wherever it is at all possible the plan has everything to commend it where industrial research is involved. The following are some of the reasons.

First, the laboratory personnel can only really know a manufacturing process and its difficulties by experience in working it themselves. It is wanted therefore for the education of the laboratory itself.

Secondly, that type of research which has its application in the improvement and cheapening of factory processes usually receives its best inspiration from research people who have had to make these processes work successfully.

Thirdly, it is essential, both for the success of efficient factory production and of successful research, to keep out of the factory all experimental work which is at all elaborate or fundamental. The disorganisation caused to production is serious, but far more serious is the disorganisation of research which results from attempting research which involves production processes when all the possible variables introduced by such processes are not under rigid control. In the case of many researches it is no use attempting work without a small factory under research control.

Fourthly, when an apparent improvement to a process is involved it must be tried in the laboratory on as large a scale as possible, in order that both the laboratory and the factory may be satisfied before attempts are made to introduce it into the works. The laboratory-factory is essential for these trials.

There are at present in the Wembley laboratories four small experimental factories for making lamps, tungsten, wire, thermionic valves, and primary batteries. The personnel engaged on the work is not large, but sufficient to carry on the regular processes.

ROUTINE TESTS.

Closely allied to the laboratory-factory are arrangements made in certain cases for the routine testing, particularly the life testing of samples of the Company's factory products. From the laboratory point of view such testing work is only justified where it assists the laboratory to form a true judgment of the factory product, and to assess the extent and the cause of defects. From the factory point of view, managements often prefer to have the regular sampling and testing of their factory product carried out away from the factory control. It is often the case also that the proper conditions of test have themselves to be the subject of laboratory investigation.

At the present time, lamps and valves are the chief factory products which are routine tested at the research laboratory and, to a lesser extent, primary batteries, but, here again, it is essential to organise so that the administration of this routine work does not fall on the man whose energies ought to be concentrated on research. Each routine department, therefore, also has a steward who is directly responsible for the work, and the research man who is a court of appeal is brought into matters affecting administration as little as possible.

The routine testing departments are valuable tools for research because men can have the products of experiments readily tested under any conditions they want without having themselves to arrange for the facilities.

A view of the department for the routine life testing of lamps is given in Fig. 4.

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Workshops.

Fully equipped workshops are provided to make up for research men such special apparatus as may be needed in connection with researches and the general equipment of the laboratories, as well as to undertake problems of their own which may, or may not, be regarded strictly as research work, but which are, nevertheless, of great help to the factory and to the applications of research to production processes. This work consists of the study of manufacturing processes, particularly those which are, or might be, carried out by automatic machinery, and the devising of machinery for increasing the speed or the uniformity of production. Often a given product can be entirely redesigned with a view to a better or cheaper form of construction, and the value of doing some of this development work at the research laboratories is that in some cases it is desirable for the designer to have always at hand a research man who will keep him straight on phases of the process and the product with which he himself cannot be expected to be familiar.

The work of improving automatic machines and processes is also always proceeding at the factories, but it is a type of work on which it is always good to have several independent minds working.

Correspondence.

To the Editor of Electricity.

Sir,—I wish to draw your attention to a paragraph entitled "Advertising and a Moral," which appeared on page 85 of your issue of February 16.

Sufficient data is contained therein to enable anyone easily to identify the organisation responsible for the advertisement, and in view of the detrimental effect which this paragraph may have upon the activities of this department, I feel compelled to register my protest against such an unwarrantable indictment of our policy.

The booklets referred to in the advertisement were distributed in the first instance to over 240,000 shareholders, who were asked to forward by means of an inset slip names of persons likely to be interested in the booklet. These applications were dealt with as and when received. In order, however, to arrive at an estimate of the effect of the advertisement referred to above, all other applications for booklets were dealt with separately and there was certainly no lack of promptitude in forwarding copies.

Your correspondent would appear to have rushed into press with a wholesale condemnation of this department merely because one application amongst several hundred thousand has miscarried in some way. I would suggest that instead of unfounded criticism, a reminder, in the form of a postcard, would have been more sensible, as it would have resulted in the booklet being forwarded by return.

This department is at present actively engaged upon a co-operative publicity campaign for the benefit of the whole rubber industry, and it is an essential to success that we secure the co-operation of the manufacturers and distributors. In view of the importance of the electrical trade in so far as the distribution of rubber is concerned, I trust that you will see your way to remove any unfavourable impressions which, to my mind, must have been conveyed as a result of your correspondent's unjustifiable remarks.—Yours faithfully,

G. R. Crowther,
Propaganda Secretary, the Rubber Growers' Association (Inc.).

February 28, 1923.

To the Editor of Electricity.

Sir,—I have read the comments of the Propaganda Secretary of the Rubber Growers' Association upon my editorial in your issue of February 16, and much regret that he appears to have construed those remarks in the wrong spirit.

The experiences referred to in my notes were based on actual fact, and were intended to point a moral of vital import to advertisers in general; for that reason no names were mentioned, and, had your correspondent not seen fit to "wear the cap," there was nothing in my article to associate his Association with the matter under discussion.

However, the fact remains that I received no reply to my request for the booklet up to the time the relevant "topic" appeared in print, and that notwithstanding the fact that my application was clearly typed, including the address on the envelope.

Mr. Crowther suggests that the explanation of the delay may be due to the accidental miscarriage of one application amongst several hundred thousand, but this theory, unfortunately, is somewhat discounted by the fact that, without any "postcard reminder," the long overdue booklet duly arrived, almost a month to the day after the original application.

Furthermore, as the initial letter of my name is early in the alphabetical list, it is legitimate to infer that, if there is still a waiting list being dealt with, there must be several thousands of applications which have brought no response. Unfortunately, I have destroyed the wrapper which accompanied my booklet, or I would have sent it to the Association as evidence of delayed receipt.

In the circumstances, and seeing that the case under review was only one of three similar experiences in connection with advertisements of widely differing character in the same daily paper, I still feel that my original editorial was fair comment on a fundamental defect in British advertising.

To ensure success it is absolutely essential to organise resources and build up stocks *before* an advertisement or series of advertisements is allowed to appear. In this particular case the campaign to popularise rubber and find new applications for this ubiquitous raw material is an excellent one, and has my best wishes for its success.

If it is any consolation to the Propaganda Secretary, I may add that the booklet, by a coincidence, *did* arrive at an opportune time, as I am interested at the moment in an important floor-covering proposition, and in the light of the information given in the booklet I am favouring rubber as a suitable material for the purpose I have in mind.—Yours faithfully,

Elektron.

Wembley, 1924.—We have received from the British Engineers' Association a first list of the exhibitors in the engineering section of the British Empire Exhibition, and are very pleased to see that over 62 per cent of the total area available has already been booked, and that by firms representative of every branch of the industry, including shipbuilding, marine engineering, mechanical and general engineering. Good luck to it.

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TRADE - STANLEY - MARK.

The largest Manufacturers of
SURVEYING & DRAWING INSTRUMENTS
in the World.

L 7 Catalogue sent post free on application : Contractors to H.M. Government

Quality Unsurpassed.

W. F. STANLEY & CO., LTD.,
Head Office—Show Room:
286, High Holborn, London, W.C.1.

JOHN OAKEY & SONS, LTD.
ANUFACTURERS OF
EMERY, EMERY CLOTH, EMERY PAPER,
CABINET GLASS PAPER, GLASS CLOTH,
BLACK LEAD, PUMICE, CROCUS, TRIPOLI,
ROUGE, &c.
Oakey's "Flexible Twilled" Emery Cloth.
For Engineers, Sewing Machine, Lock and Scale Makers, and all purposes where great STRENGTH, DURABILITY and PERFECT FLEXIBILITY are required.
FLINT & GARNET PAPER IN ROLLS.
50 yards long by 18 in., 20 in., 24 in., 30 in., 36 in., 40 in., 42 in., & 43 in. wide.
"WELLINGTON" EMERY WHEELS.
WELLINGTON EMERY AND BLACK LEAD MILLS, LONDON, S.E.1
ALL BRITISH MADE.



He's nothing in his pockets but his hands

You meet this fellow every day. He just doesn't know enough about his job. DO YOU?

Tell us TO-DAY which of the subjects mentioned below interests you—we will send you POST FREE a book which tells you how you can get that little extra knowledge which will fit you for a better job. A JOB WITH MORE MONEY.

WE TEACH BY POST

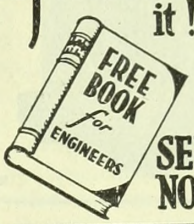
Aeroplane Engineering
Aero Engines
Electrical Engineering
Wireless Telegraphy
Electrical Installations
Electrical Control Gear
Alternating Current
Lighting (Electric, Gas, etc.)
Electric Welding
Telegraphy, Telephony
Powerhouse Operation
Mechanical Engineering
Draughtsmanship
Workshop Practice
Machine Tools
Boiler Making
Boiler Inspecting
Engineers' Quantities and Estimating
Mathematics
Electric Motor Car Ignition
Starting and Lighting Systems
Internal Combustion Engines
Motor Engineering
Commercial Engineering
Marine Engineering
Naval Architecture
Civil Engineering
Ship Design
Survey and Levelling
Building Construction
Reinforced Concrete
Structural Engineering
Municipal Engineering
Plumbing and Sanitary
Heating, Ventilating

Examinations we Specialise in:— A.M.I.Mech.E.; A.M.I.E.E.; A.M. Inst.C.E.; A.M.I.A.E.; Board of Trade Marine 2nd Class, First Class, Extra First Class; City and Guilds Exams. in Telegraphy, Telephony, etc.

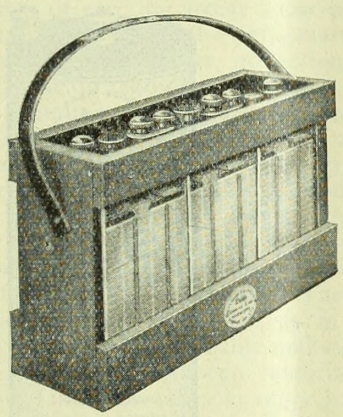
DON'T FORGET, WRITE NOW and tell us which subject you are interested in—THIS IS YOUR OPPORTUNITY. We help to place you in a Well-Paid Job when you are Trained.

THE TECHNOLOGICAL INSTITUTE OF GREAT BRITAIN, LTD.,
11, Thanet House, 231-232, Strand, London.
Australian Offices: Barrack Street, Sydney, N.S.W., Australia.

A Postcard brings it!



SEND NOW!



6 v. 40 amp. hour Exide Battery.

STAND No. 37. ALL-BRITISH WIRELESS EXHIBITION, MANCHESTER, MARCH 17th TO 24th, 1923.

Exide
The Long Life Battery.

The Principal Wireless Manufacturers standardise Exide Batteries with their valve receiving sets. They know what disappointment can be experienced by users of inferior batteries.

Exide Batteries are used all over the world, in Submarines, on Motor Cars, Aeroplanes, and for all wireless purposes. They retain their charge for long periods, do not froth, and give longest life.

They are used by the British Broadcasting Company for Transmission.

INSIST ON AN EXIDE FOR YOUR SET.

Obtainable from Wireless Dealers and Exide Service Agents throughout the country. If in any difficulty write us.

Ask for Leaflets 4027 and 4030.

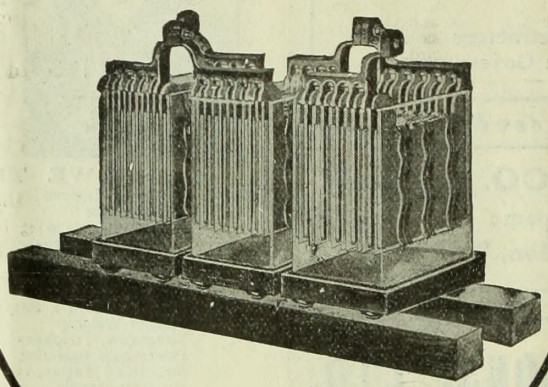
THE Chloride ELECTRICAL STORAGE COMPANY LIMITED.

CLIFTON JUNCTION, Nr. MANCHESTER. 219-229 SHAFTESBURY AV., W.C.2. 58, DALE END, BIRMINGHAM.

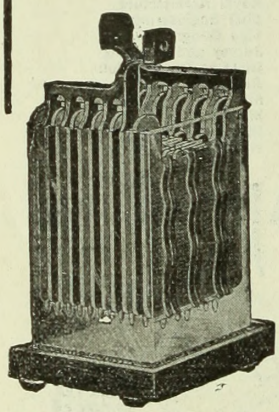
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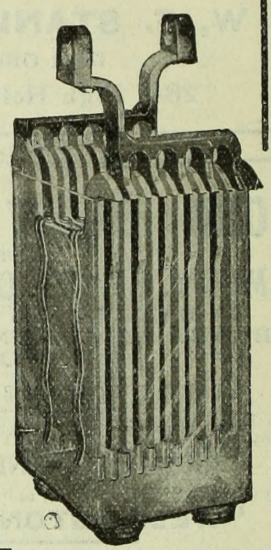
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BY INSTALLING
HART BATTERIES

HIGH EFFICIENCY
LONG LIFE
EASY TO MAINTAIN.



LOW COST OF UPKEEP
STEADY LIGHTING
FREEDOM FROM BREAKDOWN.





Hart Batteries have distinct advantages over all other makes. The superiority of Hart Cells is responsible for their extensive use in central Stations, Private Installations and general purposes of all kinds

HART ACCUMULATOR CO., LTD
MARSHGATE LANE, STRATFORD. LONDON. E.15.

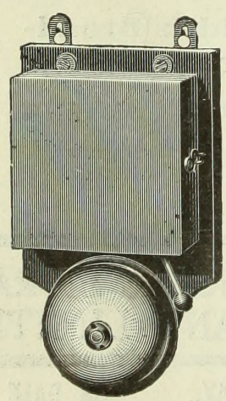
Branch Offices at—

Belfast ..	.. 41, Chichester Street.	Manchester ..	4, Victoria Bridge.
Birmingham	.. 174, Corporation Street.	Westminster ..	36, Victoria St., S.W.1.
Bristol ..	.. 37, Victoria Street.	York	6, Bridge Street.
Glasgow	.. 107, Wellington Street.		

Good, steady, all-the-year-round trade

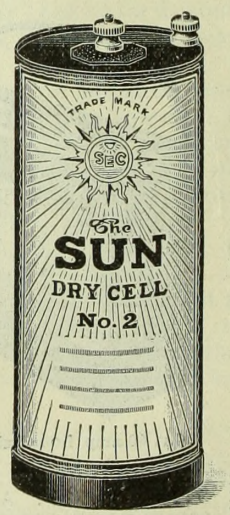
in electric bells and materials is yours. From the many different types stocked by the Sun you can select those best suited to the requirements of your customers, with the knowledge that they represent honest value for money.

SUNCO BELLS AND— BELL MATERIALS



Every item—bells, indicators, batteries, wires, sundries, is stocked in many qualities—even the cheapest will give reliable service, and cause you no complaints.

Why not write us now for quotations?



Write for a copy of the Sunco Monthly Price List of Bell Material.

THE SUN ELECTRICAL Co. LTD.
118-120, CHARING CROSS ROAD
LONDON — W.C.2.

Telephone - - - - - *Gerrard 7766 (6 lines).*
Telegrams - - - - - *Secabilis, Westcent, London.*

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TO OUR READERS.

ELECTRICITY is published every Friday, and, if ordered, is on sale at the principal Railway Station Bookstalls and Newsagents on that day. It has a very large sale throughout the United Kingdom, as well as in the British Colonies and Abroad.

New advertisements for the displayed columns and alterations to existing ones must reach the publishing office not later than first post Tuesday morning, in order to be in time for the issue of the following Friday. This is important. Rate quoted on application. Subscription: 13s. a year, 6s. 6d. half year, 3s. 3d. a quarter in advance, postage prepaid in the United Kingdom and abroad.

All remittances payable to the Publishers, S. RENTELL AND CO., LTD., 36-39, Maiden Lane, London, W.C.2. Telephone No. 2460 Gerrard.

Current Topics.

The Real Cost of Electricity.

In one of a very interesting and instructive course of lectures now being delivered by Professor Dron in the Geology Classroom of Glasgow University, the lecturer threw some interesting light on what really constitutes the cost of electrical energy as supplied at the consumer's terminals. Dealing with the application of electricity to colliery work, he mentioned that at a comparatively small power station of one of the Scottish power companies the cost of electricity for the month of January, 1923, was only three-tenths of a penny per unit, delivered at the station switchboard. The cost for fuel amounted to about one-tenth of a penny, and the administrative and capital charges to two-tenths. The prices charged to consumers, on the other hand, vary from 1d. up to as much as 1s. per unit. It was the cost of distribution, not the cost of production, which was the most potent factor in determining the price.

A modern colliery equipped with an electric power plant on a fairly large scale could produce electricity at ¼d. per unit, and the cost of distribution was reduced to a minimum. Where power, which would otherwise be wasted, could be obtained from exhaust steam and coke-oven gases, the fuel cost was still further reduced. The idea of erecting great super-power stations made a certain appeal to the imagination, but the possibilities attached to the utilisation of all sources of waste heat at collieries provided a much safer and more economic line of development. The ideal site for a super-power station is, of course, alongside the pithead, but, owing to the geographical distribution of our British coalfields, the problem of distribution costs bulks large, and even with E.H.T. overhead power transmission there is still a considerable loss in efficiency and multiplication of the cost per unit at distant consumers' terminals. The proof of Professor Dron's reasoning is to be seen in the continued prosperity of the big cable-making concerns, whose prosperity has never been materially affected by the rise and fall of business in other branches of the electrical industry. Wherever it is generated, electrical energy must inevitably be conveyed to the point of consumption, whether near or distant, and we are yet, apparently, no nearer the solution of wireless transmission of power

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Telephone Humours and Rumours.

Under the new regime the Post Office Telephone Department would appear to be making genuine efforts to remove some of the causes for dissatisfaction with the public telephone service which have occasioned such general and bitter complaints in the past. If the programme for converting certain exchanges to automatic working, recently published in the Press, is genuinely proceeded with, this in itself should go far towards removing many of the troubles incidental to the human factor in operating, and is really the logical policy, in view of the official statement made to a *Daily Mail* representative the other day. According to this authority at the London Telephone Controller's office, every effort is made to get an efficient staff of operators. Out of a very large number of applicants a high percentage are rejected on account of imperfections of hearing, eyesight, and articulation, and the girls accepted are given a month's training in an operators' school. The Post Office is constantly taking a secret check to test imperfections in working, and it rarely works out at more than four per cent. of wrong numbers. It must also be remembered, says the official, that the call is repeated by the first operator to the other girl who makes the connection to the distant subscriber, so there must be considerable scope for error.

In the face of this frank admission of the underlying causes of many subscribers' complaints, one marvels that the authorities have dilly-dallied so long in applying the obvious remedy, which, moreover, has been pointed out to them repeatedly by telephone engineers and other impartial observers for the past eleven years, viz.: Get on with wholesale conversion of the system to automatic working and dispense with the operator altogether. Telephone switching in metropolitan areas to-day is admittedly and increasingly complex, but highly efficient mechanism exists for dealing with it, and developments in automatic working are ahead of the applications of this principle in Great Britain, as evidence a recent article in the columns of ELECTRICITY. Apropos of the official request to subscribers to report wrong connections, a humorous contemporary remarks that—"The best type of subscriber, of course, generally has his complaint set to music and sings it."

Broadcasting.

The possibilities of broadcasting in this country are legion, and in my humble opinion we are only at the beginning of a boom which will outlast the two years' protection afforded to British manufacturers of the necessary apparatus. For the benefit of the new pastime, however, it behoves both the Post Office and the Broadcasting Company to use every endeavour to maintain and improve the quality of the entertainments and general announcements broadcasted. To this end it may be necessary to link up leading theatres, places of worship, public halls, and other locations where well known performers, public speakers, preachers, etc., deliver their original songs, speeches and discourses, with the actual broadcasting stations. It is impossible to set up broadcasting transmission facilities at all the desired venues, and, failing this, the alternative is an ordinary telephone transmission link at the originating end. This should not be difficult to arrange, even in the case of the seat of Government, although, replying to such a suggestion by Mr. Ben Tillett in the House of Commons recently, the Premier stated that he did not think such a facility was desirable. Possibly he had in mind the effect of certain Labour utterances upon the delicate susceptibilities of many listeners-in, or he may have been influenced by the growing list of gas escape tragedies.

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Maxims of Industry.

The considered pronouncements of well known and experienced captains of industry and commerce are generally worth hearing and, in most cases, adopting as personal mottoes by those similarly situated in the lesser ranks of life. Here are a few utterances which contain much worldly wisdom. Lord Leverhulme, at a Manchester public luncheon, commented on the value of a smile. Referring to his Chairman, the Lord Mayor of Manchester, he stated—"I never met a chairman who had such a beautiful smile," and added that when in the United States he heard that a competitor of Mr. Schwab's had said he would give a hundred thousand dollars for Mr. Schwab's smile. "If he saw your smile," said Lord Leverhulme, "he would give a million dollars for it." He had known customers wait in a queue in a grocer's shop to ensure being served by a man with a smile. There is much to be said for the somewhat forcible injunction :" Smile—D - - n You—Smile."

Here is another sage announcement from Mr. G. M. Harroway, vice-president of the North-East Coast Institution of Engineers and Shipbuilders. "Why should the inferior workman be the basis of payment for all?" "We must alter the trade union idea of the minimum wage. It is wrong in principle. Wages should be paid in accordance with individual effort, and it is high time that men should be allowed to give of their best, and be paid accordingly." Another of Lord Leverhulme's maxims—"If we leave the human factor out of our calculations we shall be wrong every time. At the same time there is no place for philanthropy in business. There are only two classes of workers, whether directors or office boys—those who do their duty and those who fail to do it." Other sound maxims of a like nature are to be found in a recently published book from the pen of Mr. George R. S. Gallaher, retired manager London Joint City and Midland Bank, Lothbury, London. Thus—"The least meritorious are frequently the most fortunate. The operations of chance seldom coincide with justice, as was the case when the lot fell upon Jonah."

Other jewels from the same casket are—"The chronic grouser and grumbler is seldom successful in remedying what he thinks is his grievance." "Fellow clerks or co-workers often foresee the coming man—before his employers." Another excellent maxim—"The young man who aspires to a position of importance should at a very early age make a beginning in the art of public speaking." As for foreign languages—"There is scarcely one boy in a thousand coming direct from school to a commercial office who can write the very simplest letter, or carry on the most elementary conversation in a foreign language." Mr. Gallaher might have added, and with equal truth, "or in the English language of his birthright."

The Electrical Wholesalers.

I congratulate Mr. Beaver and the members of the Electrical Wholesalers' Federation on the success of the annual dinner, which was held on the 1st inst. There were some excellent speeches, marked throughout with a tone of optimism and cordiality which speaks well for the business relationships between this federation and the other trade associations in our great industry. The toast of those kindred associations was put very ably by Mr. Beaver, and replies were given by Mr. J. S. Highfield, for the I.E.E.; Mr. Riggs, for the N.E.C.T.A.; Mr. Brewer, for the E.L.M.A.; Mr. Dunlop (D.N.D., *not* D.U.D.), for the B.E.A.M.A.; Mr. Huddleston, for the C.M.A.; and last, but by no means least, Mr. Beauchamp, for the E.D.A., which may be truthfully likened to the faithful slave who will nurse and help all the big boys and girls to grow into gigantic proportions.

Then Mr. J. Y. Fletcher told us about his amusing clothes-changing experience in the train that afternoon, as well as the heartbreaking times of the year 1922 due to the general state of world unrest, but cheered us up by saying that he seriously thought we could be optimistic, and altogether made a very good speech in proposing the actual toast of the evening, viz., "The Electrical Wholesalers' Federation," to which Mr. Beaver made a suitable reply. Mr. Dennis said nice things about the terrible Press, of which he stood in such awe; and Mr. Whyte, who responded, told the Federation that we should honestly like to hear from them more often than once a year, a sentiment with which I am in cordial agreement. There was an excellent musical programme interspersed between the speeches, and from the hearty way in which everyone joined in "Auld Lang Syne" I am certain that the members of the Federation must be looking forward to more prosperous times in the near future—very near, to judge by "Bobby" Smith's beaming smile.

Engineering at Olympia.

Most of my readers are aware that in the autumn of this year there will be a Shipping, Engineering and Machinery Exhibition at Olympia, similar to those which were held in 1919 and 1921. Dr. H. S. Hele-Shaw is the chairman, and Mr. F. W. Bridges the organising manager, so I am not surprised to hear that it is meeting with the very hearty support of the great trades which it will represent. On this occasion the Motor-Boat Exhibition will be combined with it, and it will occupy the whole of the building, including the new extension which is now open. It will, therefore, appeal to a very much larger circle of trade clients, and there is not the slightest doubt that it will reflect the steady improvement which is now showing in the engineering and allied industries.

On the 28th ult., Dr. Hele-Shaw presided at a luncheon, when the exhibitors were invited to meet the honorary committee of experts associated with the exhibition, and much interest was taken in Mr. Bridges' reports on the progress being made, as well as in the generally hopeful outlook. Practically every day of the Exhibition is booked for a visit from one or other of the scientific institutions, both home and foreign, and the official opening is to be carried out by some well-known personage whose name will be announced in the near future. If any firm wishes to exhibit and has not yet booked a space, it should lose no time in doing so, as a goodly attendance of likely clients is practically assured at the outset, and that on a rising market.

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No, this is not "Bill Stumps his mark," but the letters representing the paper on "The Industry, The Press, And The Public," read by my worthy friend, Mr. Adam Gowans Whyte, at the E. D. A. Salesmanship Conference on March 2. Mr. Wordingham was in the chair, and in his opening remarks referred to the decision of the Council of the I.E.E. to open the columns of the Institution Journal to advertising clients. That was one of the points touched upon by Mr. Whyte in his paper, and I can say at once that it is a very sore point with the five bona fide electrical weeklies. They look on it as deliberately unjust subsidised competition from an institution which they as members of the electrical profession are expected to support, and in many cases do actually subscribe to. It is the same principle as the rate aided competition to which, for example, electrical contractors make such vigorous objection. It is not fair play. In our industry a certain amount of cash is devoted each year to publicity. It is spent by the firms in it, large and small, and is spread over the papers at present doing their best to furnish the trade readers with trade news and technical information. Each receives its quota according to its deserts.

T.I.T.
P.A.T.
P.

If, therefore, an Institution journal with a large free list enters the field and opens its pages to trade advertisements, the amount divided among the bona fide newspapers is reduced proportionately. Perhaps it may not so happen in some cases, but I am referring to broad general results. One firm spending £1,000 per annum may decide to spend £1,100, but in the majority of cases the £1,000 would have to be divided up so as to include the newcomer. Therefore, the others lose a certain proportion of their income, but they are expected to extend their benevolent support and interest to the institution just the same, simply because it is part and parcel of ourselves. No, it isn't justice, and the same remark applies with almost equal force to certain other subsidised publications which do their utmost to compete with legitimate jounalism, but have no real sale in the correct newspaper sense of the term, and in which the advertisers simply have the pleasure of studying other competitive advertisements. Very pretty, but it isn't business. To these also Mr. Whyte made reference in his paper.

The real trouble with Mr. Whyte's very able address was that we couldn't pick holes in it. I should have much liked to have seen a larger attendance and to have heard some trenchant criticisms, if only for the sake of gaining any knowledge which will help to improve and widen our journalistic field. Mr. Allen spoke on behalf of the *Review*, Mr. Hughman and Mr. Slater for the *Times* (electrical, of course), Maj. Masters for the *'Trician*, and Mr. Alderson Smith had a dig at the author on behalf of his own paper, while outside speakers included Mr. Robinson, of Hackney, who is evidently a gentleman well in touch with his local Press, Mr. Ruthven Murray, Mr. Marryat, Mr. Gillott, Mr. Pryor (of Siemens Supplies publicity fame), Mr. Byng, and last but by no means least, friend Beauchamp himself. At the close Mr. Whyte dealt very efficiently with the points which had been raised, and the meeting closed with a hearty vote of thanks for his assistance in ventilating a subject which could well be dealt with again at a later date. ELEKTRON.

LABORATORY WATER BATHS.

A new and improved series of electrically heated water baths for laboratory use has recently been included in their range of industrial electrical heating appliances by the Cressall Manufacturing Co. (40 and 41, Staniforth Street, Birmingham). These baths are made of cast-iron, white porcelain enamelled inside and japanned outside. A special feature is to be found in the extended recessed rim (which is part of the bath itself) to support the concentric copper reducing rings. These



have a curved inside edge, which gives a better grip than the ordinary plain edge. Three-heat regulation can be provided, as can an inlet and constant water level attachment (see illustration), which, in addition to being screwed in, is secured by set-screws, so that it is impossible to shift from the vertical position. The heating elements are easily replaceable, being secured by two screws only.

Questions and Answers by Practical Men.

RULES.

QUESTIONS: *We invite our readers to send us questions, preferably on technical problems that have arisen in actual practice. Questions which we consider of sufficient interest to our readers will either be replied to under "Answers to Correspondents" or replies will be invited from our readers. One shilling will be paid for the question which we select for competitive replies in this column.*

ANSWERS: *A fee of 10s. will be paid for the answer which we consider shows the greatest merit, and 5s. for the one we select as second best. In judging the replies, importance will be attached to clearness and conciseness, as well as accuracy. The Editor reserves the right to make no award, or to accept only one reply, if, in his opinion, the answers received do not possess sufficient merit. Competitors desiring the return of their manuscripts, if unaccepted, should enclose stamped addressed envelope.*

Write on one side of the paper only, and if diagrams are sent, draw them on a separate sheet of paper attached to the manuscript. Competitors may adopt a "nom de plume," but, both in the case of questions and answers, the competitor's real name and address must be sent with the manuscript as a guarantee of good faith. No correspondence will be entered into with regard to successful replies. The Editor's decision is final.

Commencing with Question No. 101, a Diploma of Merit will be awarded to the six competitors who win the first or second prize the most times during the next twelve months.

The words "Questions and Answers" or "Q" and "A" should be placed at the top left-hand corner of all letters intended for this column.

QUESTION No. 155.

Can anyone give me details which govern the selection of a fuse carrier? I desire some for use on the following service:—Volts 440 d.c., 50 amperes, three wire.—"Cable."

QUESTION No. 156.

Can any reader give me information concerning a good method of indirect lighting. I have a small study where I do a lot of drawing, and I find the ordinary electric light is very trying for my eyes.—"Pen."

(Replies to Questions 155 and 156 must be received not later than March 31, 1923.)

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ELECTRICITY SUPPLY IN LANCASHIRE.

The Electricity Commissioners have held their inquiry at Preston into the joint scheme of Blackburn and Preston Corporations for electrical development in Mid-Lancashire under the Supply Act of 1919. The scheme proposed a joint authority for the district with powers to deal with the generation and "bulk" transmission of electricity. To this end it was suggested that between now and 1931 all existing stations, except those at Blackburn, Preston and Rawtenstall, should be closed, and that the normal supplies for the district should come from three "capital" stations at Blackburn, Burnley and Preston, existing generating stations to be retained for a time as "peak load" or emergency stations. The new authority was intended to consist of representatives of local councils in the district who are "authorised undertakers," and they were to agree to afford financial assistance under the provisions, including the Lancashire City Council. The district comprises the county boroughs of Preston, Blackburn, Burnley and Blackpool, the boroughs of Accrington, Bacup, Chorley, Clitheroe, Colne, Darwen, Haslingden, Nelson and Rawtenstall, and various urban district and rural district councils in the area. The scope extends between Preston (in the west), Colne (in the north-east) and the residential districts of the Fylde. The industrial portion is important, for it represents all branches of the textile industry.

Opposed to the scheme were Burnley, Accrington, Colne, Nelson, Bacup, Haslingden, Rawtenstall, Blackpool and Darwen, and the urban locality of Brierfield. They proposed a joint electricity board with advisory functions only, contending that a retention of existing control and supply would result in more efficient and economic distribution. The Commissioners were:—Sir J. Snell (chairman), Sir H. Hayward (vice-chairman) and Mr. W. W. Lackie, with Mr. E. W. Hudson (legal adviser) and Mr. D. S. Cumberlege (clerk).

After considerable evidence had been given it was announced that the parties had agreed on a scheme which provided for the establishment of a Mid-Lancashire Committee to include the county boroughs of Blackburn, Burnley, Preston and Blackpool, with various municipal boroughs and urban and rural district councils. The whole of the outstanding matters, it was stated, had been jointly agreed upon with the exception of one question, which was still the subject of negotiations. The new committee would appoint an inquiry committee consisting of the borough electrical engineers of Preston, Blackpool, Blackburn, Burnley, Accrington, Rawtenstall, and those to the Lancashire Power Company and the London and Midland Railway Company to give advice and assistance, and the scheme was to become effective within two years from the drawing up of the scheme. Proposals would be submitted to the commissioners for securing the supply of current in any area within the district in which there was a reasonable likelihood of such supply being remunerative. The main provisions for the technical scheme are:—For the generation of three-phase alternating current, with a standard frequency of 50 cycles per second. For the transmission of electricity the standard pressure shall be (between phases) in the case of main transmission lines 33,000 volts, and in the case of secondary transmission lines 11,000 volts and 6,600 volts.

The exceptions to the standard three-phase, 50-cycle, alternating system are:—(1) Bispham, Blackpool, and Fleetwood Tramways, Preston Tramways, Lytham-St. Anne's electricity supply, operating on the direct current system; (2) Blackpool Corporation system operating at a frequency of 85 cycles per second; (3) the existing frequency at Blackpool will be supplied through frequency changers. All extensions will be carried out at the standard frequency of 50 cycles per second. The following generating stations will be continued under the new scheme:—Accrington, Blackburn, Blackpool, Burnley, Colne, Darwen, Fleetwood, Nelson, Preston, Rawtenstall and St. Anne's. A new generating station will be erected in Burnley district either by the Corporation or by the Lancashire Power Company. The other stations will be closed down as required. Main transmission lines will be laid between Preston and Blackburn, Blackburn and Accrington, Accrington and Burnley, Burnley and Nelson, Blackpool and St. Anne's. A scheme of control will be prepared by the engineering committee for approval.

Sir John Snell said the commissioners were gratified that the authorities had been able to arrive at some agreement, and they hoped it would bring about an improvement and larger use of the supply of electricity in the area.

THE IDEAL HOME EXHIBITION.

The Ideal Home Exhibition, promoted by the *Daily Mail*, is with us again, the seventh of the series having been opened on Thursday of last week. It will remain open until the 24th inst., and is well worth a visit, seeing that it is up to the high standard of interest set by the preceding exhibitions. An added attraction is to be found in the fact that the New Hall of the big extension to the original building is opened for the first time, and is used to accommodate "Bungalow Town," while among the exhibitors in the gallery of this hall are to be found over two dozen leading firms in the new broadcasting art. All afford the visitor specialised advice, and exhibit all kinds of excellent apparatus. The firms represented include such well-known ones as the Automatic Telephone Manufacturing Co., Ltd.; the B.T-H. Co., Ltd.; S. G. Brown, Ltd.; C. F. Elwell, Ltd.; the G.E.C., Ltd.; Alfred Graham and Co.; the Marconi Companies; the Metropolitan-Vickers Electric Co., Ltd.; Siemens Bros. and Co., Ltd.; the Sterling Telephone and Electric Co., Ltd.; the Western Electric Co., Ltd., etc. This section has been organised by the National Association of Radio Manufacturers, and, coupled with wireless concerts given in the Minor Hall (Main Hall Gallery), is an education in itself.

In the Annexe we have again the very attractive "Royal Gardens," while in the Main Hall and Gallery we find groups of manufacturers conveniently classified according to the nature of their products. Electricity supply from self-contained sets is represented, and electric labour-saving devices of all kinds are to be found in, we believe, greater profusion than in most of the earlier Ideal Home Exhibitions. At any rate, the latest appliances as developed by the following, among others, may be seen and proved:—Belling and Co.; British Electric Transformer Co., Ltd.; Credenda

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Conduits Co., Ltd.; Dowsing Radiant Heat Co., Ltd.; L. G. Hawkins and Co., Ltd.; the Hotpoint Electric Appliances Co., Ltd.; and Electric Utilities, Ltd.—all of whom specialise in heating and cooking manufactures. Of course, one may also find the ever-popular vacuum cleaner shown by many firms, as well as applications of small-power motors, including a fine display of electrically driven sewing machines by the Singer Sewing Machine Co., Ltd. A newcomer with electrical heating and cooking appliances is Chas. H. Smith and Co., of 277/8, Bank Chambers, 329, High Holborn, W.C.1. Some of the appliances are not likely to prove very attractive in this country, but mention should be made of a neat and strong three-heat boiling ring with concentric elements, embedded in fireclay cement; a thermal storage water heater and bowl fire, with elements similar to those used for the boiling ring, which, it should be mentioned, comes to pieces most easily for cleaning. The case is made of enamelled pressed steel.

The Rawlplug Co., Ltd., effectively demonstrate the proved advantages of the Rawplug for fixing *anything* to stone, brick, glass, cement, tiles, etc.; and in conclusion we should mention that the Western Electric Co., Ltd., have fitted up their "Public Address System" (as used recently at the I.E.E. dinner to render audible at all points the various speeches), so that the band music may be heard throughout the huge building. It will be remembered that the sound waves are picked up by receivers, valve amplified and distributed to telephone loud speakers erected at all necessary points.

"WIRED WIRELESS"—LINE RADIO.*

By Major J. A. Mauborgne, United States Signal Corps.

(*Concluded from page* 117.)

A number of plugs to screw into the electric light socket, including in their structure condensers suitable for connecting to the light lines, are now on the market, and the one known as the "Super-Antenna," designed by Radio Engineer Duncan of the Signal Corps, is found to meet all requirements, giving both suitable protection and satisfactory results.

The use of the line radio method of broadcasting as compared with space radio broadcasting has many advantages. In the first place, the ether channels used for space radio broadcasting are limited, and even the few wave channels which are available for broadcasting can be more profitably employed for such radio activities where space radio is the only or best method of communication. By space radio is meant ordinary radio telephone transmission. Also, since there is practically no radio interference caused by broadcasting on power lines or light lines, any number of wave channels may be employed, thereby multiplying the number of stations which can be operated on the same line.

It is conceivable that in every community we may have several transmitting stations, operating at the same time but each on a different wave length and supplying different services. One may be used exclusively for music, another for current news, and still another for educational information. Obviously, by this means of broadcasting, no antenna is required for reception. In order that the radio broadcasting by the foregoing method may be received, a suitable plug connection in the electric light socket is all that is necessary wherever the lighting circuit exists.

During the recent experiments of the Signal Corps in connection with this wired wireless broadcasting over electric lighting lines, carried on during the month of May of the present year by a Signal Corps engineer in co-operation with the North American Company and the Cleveland Electric Illuminating Company, very successful wired wireless broadcasting was accomplished over the lines of the latter company, in Lakewood, on the outskirts of Cleveland. A very complete account of the results obtained, together with the descriptions and diagrams of the apparatus used, can be found in the article of R. D. Duncan, Jr., "Wired Wireless Broadcasting," *Electrical World*, Volume 80, No. 8, Page 367, for August 19, 1922.

The conclusions drawn from the Washington and Cleveland experiments are that from a technical standpoint wired wireless broadcasting over electric power lines is entirely feasible, and that with the proper choice of wave lengths the radiation from the lines may be reduced to such an extent that it will not interfere with radio communication.

Apart from the subject of actually broadcasting material over the power lines themselves, attention is invited to the fact that these lines, if connection thereto be made by the condenser plug mentioned, offer a very fine means for receiving from ordinary broadcasting stations, thereby, of course, doing away with the ordinary antenna.

Similarly, a matter which is of considerable interest to the telephone companies is that telephone lines can be used both for wired wireless broadcasting after the manner described for light lines and with practically identical connections, as well as for the reception of signals from ordinary broadcasting stations, the lines in this case being simply used as antennæ. This, of course, raises the question as to the right of telephone companies to charge for and control any and all additions or connections to their wires, which are really the property of the individual companies and not public property.

Telephone contracts should be redrawn at once in such shape, for the protection of the companies, that no piece of radio apparatus, transmitter or receiver, shall be connected to any telephone line without licence from the telephone company, and then only with such connecting devices as shall have been approved and sold by the telephone company concerned. These ordinary precautions, and the sale to individuals of suitable devices for connecting to telephone lines, with a numbered licence issued in every case, should give the telephone companies an additional income for the use of their lines in connection with the reception of matter broadcast either in the ordinary way or over the lines.

It is suggested that, until further experiments are carried out by radio engineers in connection with the telephone lines, no transmitter be licensed to broadcast over any telephone line, because of the confusion which may occur and possible damage to terminal and switchboard apparatus if proper precautions are not taken.

In conclusion, I wish to state that it is my belief

* *Telephony*, Chicago.

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that telephone companies should investigate this wired wireless proposition very carefully and without delay, not only because of its possibilities for multiplex telephony, but also for the last two features mentioned, namely, the use of telephone lines for broadcasting by wired wireless, and the use of such lines as antennæ for ordinary reception. I regret that more time could not be given to an exposition of this important subject, but I feel that it is one which must be carefully studied and that much experimental work must be done in connection therewith by those interested before a clear understanding of the subject can be reached.

Various Items.

Accrington.—The B.T.-H. Co., Ltd., have secured an order from the Electricity Committee to reblade the 2,000 kw. turbine.

Blackpool.—The Education Committee have approved plans for a new secondary school. Plans for a new elementary school are being prepared.

Kingston-on-Thames.—The Corporation are to provide an electrically wound clock with chimes, playing four tunes, for the tower of All Saints' Parish Church.

Concert.—The last Electro-Harmonic smoking concert of the season will be held in the Caxton Hall, Westminster, on Wednesday, 14th inst., at 8 p.m. Chairman, Sir James Devonshire, K.B.E.

Cardiff.—To advance the art of window and counter display work and to promote salesmanship, a "Better Sales Association" has been formed under the Presidency of the Lord Mayor. The membership is over 100.

Gas as a Fuel.—On Friday, 9th inst., a lecture, entitled "Gas as a Fuel," will be given by Mr. J. G. Clark before the Inst. of Heating and Ventilating Engineers, at the Engineers' Club, Coventry Street, London, W.1, commencing at 7 p.m. The meeting is open to non-members, and is likely to interest many electrical engineers.

Spring Cleaning.—The Metropolitan Vickers Co., Ltd., of Trafford Park, Manchester, are now making quite a big push in their Cadillac Vacuum Cleaners, and retailers who wish to join in the business campaign can be supplied with leaflets Y4150/6 overprinted with their own name and address if they will write to the company asking for a supply.

A Well-earned Rest.—Mr. James Smith, A.M.I.E.E., the oldest member of the Edinburgh telegraph staff, has now retired, and we wish him many years of quiet happiness in the future. In the olden days he contributed regularly to our columns over the letters "U. K.," and he was also the author of "The Telegraphists' and Telephonists' Note Book," a work which is now out of print. His technical abilities were of a high order, and he was lecturer on telegraphy, telephony and telegraph engineering at the Heriot-Watt College for over twenty years.

The Practical Electrician's Pocket Book.—Readers who have been waiting patiently for the appearance of our annual pocket book will be glad to hear that this is now on the market. The delay was due to the unfortunate strike in connection with the bookbinding industry, but we can assure them that they will be amply compensated by the extra value which the book represents. It is now 570 pp., and the addition of an important and eminently practical chapter on "Broadcasting" has added much to its utility. In addition, the other sections have been most carefully revised, and we can say without hesitation that the pocket book is more essential than ever. The price is 3s. net from any bookstall or bookseller in the kingdom, or 3s. 4d. net post free from S. Rentell and Co., Ltd., 36, Maiden Lane, London, W.C. 2.

Meetings.—The Birmingham and District Electric Club will meet on Saturday, 10th inst., at the Grand Hotel, at 7 o'clock Lecture: "The Wave Transmission of Power," by Mr. Dinwoodie (slides).——The Junior Inst. of Engineers will meet at 39, Victoria St., S.W.1, on Friday, 9th inst. Paper: "Rolling Mill Machinery," by L. C. D. Fell; also, on Friday, 16th, "Comparative Power Costs," by C. H. Woodfield (Member), and on Friday, 23rd, lecturette, "The History and Development of the Underground Railway," by Mr. R. J. Siddall (Member). Slides. All at 7.30 p.m.——The next meeting of the Scottish Centre of the I.E.E. will be held at the North British Station Hotel, Edinburgh, on Tuesday, 13th inst., at 7 p.m. Paper: "The Maintenance of Voltage on a D.C. Distribution System by means of a Fully Automatic Sub-station," by P. J. Robinson.

Reduction.—After March, the Chelsea E.S.C., Ltd., will reduce the rate for lighting to 7½d. per unit.

Faraday House Old Students' Association.—The Rules and List of Members for 1923 has been published. The President is Mr. H. W. Miller, and the Vice-Presidents, Dr. F. T. Chapman and Mr. P. J. Watts, O.B.E. Mr. H. W. Fairman (Sec. Faraday House, 66, Southampton Row, W.C.1) is the Hon. Sec.

Personal.—Mr. G. W. P. Page, A.C.G.I., A.M.I.E.E., who has had a varied experience in theoretical and practical engineering, besides having been engaged in engineering, journalistic and publicity work, informs us that he has opened an office at 36, Maiden Lane, Strand, W.C.2, on behalf of Fisher, Knight and Co., Ltd., general printers and publishers, bookbinders, relief and die stampers, engravers and advertising specialists, etc. Mr. Page's personal services are available in connection with all engineering publicity matters. (Telephone: Gerrard 2460.)

Trade Notes.

A bold "Mazda" lamp adhesive window sign for easy fixing on the inside of windows is available for the use of contractors and electrical dealers. Apply, **The British Thomson-Houston Co., Ltd.** (77, Upper Thames Street, E.C.4).

A new price list for March, 1923, has just been issued by the **London Factors and Agents, Ltd.**, of 38-39, Parliament Street, S.W. 1. It follows the company's usual practice of keen prices worked out to net figures in order to save contractors' time in pricing estimates. It should certainly be in the hands of all contractors and installation engineers.

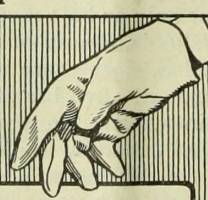
The **G.E.C.** have issued an interesting leaflet (called "Technical Description No. 233") dealing with A.C. motor control. One of the illustrations shows the gear for the control of a large rolling-mill motor.

A catalogue giving details, illustrations and prices of A.C. and D.C. motors and dynamos, as well as of transformers, has been issued by **Messrs. Todman, Ryall and Co., Ltd.** It is a well-printed book, and sets forth in clear terms the advantages claimed by the company for their manufactures. They will be pleased to send a copy to any reader on receipt of trade card, and we recommend all installation contractors and factors to apply for same without delay.

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ELECTRICITY SUPPLY DEVELOPMENTS IN THE UNITED KINGDOM.

THE BRIGHTER OUTLOOK—ENORMOUS DEVELOPMENTS FORESHADOWED—POSITION OF EXISTING UNDERTAKINGS—NEED FOR CO-OPERATION.

The second annual report of the Electricity Commissioners for the year ending March 31, 1922, lays stress upon the severe industrial depression which prevailed throughout that year, and upon the uncertainty which existed as to the date and scope of the further legislation necessary to enable full effect to be given to the policy of reorganisation laid down in the Electricity (Supply) Act of 1919. The views of the Commissioners were sought whilst the framing of the unemployment legislation was under consideration, and various suggestions which seemed to them to be of practical value were put forward for action. Doubtless these measures have already alleviated the position to some extent, and their full effect has probably yet to be felt. Notwithstanding the general depression, steps were taken to improve the organisation for the supply of electricity in different parts of the country, and these steps will no doubt have a beneficial effect upon the welfare of the country as trade revives. The electricity supply industry constitutes, to a peculiar degree, an index of the general conditions of home trade owing to the important and increasing extent of the applications of electric power to industry. Improvement in the position of supply undertakings, coupled with a rising curve of output, will therefore constitute one of the first signs of an improvement in the condition of industry generally, and, we may add, this improvement and this rising curve of output have been very marked during recent months. There is, therefore, every reason to suppose that the long-delayed improvement in industry has at last commenced.

The work undertaken by the Commissioners in bringing about an improvement in the existing organisation for the supply of electricity was the most prominent feature of the year under review. In addition to preliminary surveys leading to the provisional determination of further districts, the Commissioners devoted much time to the consideration of schemes submitted for a number of districts, and to the preparation of decisions embodying approved schemes. A detailed statement of the work accomplished in this and other directions is to be found in the report itself.*

There appears to have been a prevalent idea that the Commissioners themselves were engaged in carrying out a "national scheme" involving the construction of a number of super-stations from which supplies would soon be available for all towns and villages requiring electricity. This, of course, is by no means the case. The Commissioners are required by the Act of 1919 to afford to those concerned in the question of the supply of electricity in any district an opportunity of submitting a scheme of reorganisation, but, whilst the coming into operation of a scheme will improve the prospects of those areas which have at present no supply, it will not necessarily result in supplies becoming immediately available.

There has been a considerable amount of understandable anxiety amongst the owners of private undertakings as to their position in the new regime. These persons, to whom the electrical industry and the public in general owe a debt of gratitude for their enterprise in the past, will be relieved to hear that the coming into operation of a scheme for a district will not affect the position of the owner except with his consent, nor will it affect the freedom of any consumers to continue to take supply from the private station. Subject, however, to the terms of the agreement between the owner and his consumers, it would be open to the latter to take supply from an alternative source. On the other hand, the establishment of a comprehensive distribution system should ultimately be to the benefit of all private stations by providing an outlet for surplus supplies generated during week-ends, etc., or by enabling the private station to take from the public system such supplementary supplies as may be required. The position of a non-statutory undertaking giving general supply for lighting and other purposes will be rather different, for a Joint Electricity Authority, if established, would be entitled to compete in the area of an existing non-statutory undertaking (but not in areas of supply of any authorised distributor). Alternatively, the Joint Authority would be entitled to acquire the non-statutory concern by agreement with the owners. In most cases this would probably be the best solution from every point of view.

Interconnection of the principal generating stations is an essential requirement for the reorganisation of electricity supply in large districts containing many authorised undertakings, and the extent of the improvements and the economies effected is dependent upon the extent to which the undertakers concerned are prepared to co-operate in pooling the resources of the interconnected stations for the common good. Interlinking alone for the purposes of bulk, reciprocal and stand-by supplies will result in considerable economies; but for maximum benefits the interconnected stations worked should all be operated under a unified control

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in accordance with a schedule of working designed to meet all phases of the requirements of the district. The conferring upon the Joint Authority of sufficient powers of control over the working of interconnected stations appears to be the absolute minimum from which the desired improvements can be obtained. The better alternative and the one which, in the opinion of the Commissioners, will result in the most satisfactory reorganisation of supply and lead to maximum economies, is the vesting of the central supply system in a Joint Authority. It is essential, however, that the transfer be effected on reasonable terms. Agreement to the vesting of the interconnected station constituting the central supply system for a district, or, alternatively, acceptance of a unified system of control will constitute the acid test of the sincerity of co-operation among the authorised undertakers concerned. The desire for improvements in the position of electricity supply has been voiced loudly from all parts of the country, and the undertakers concerned have now the opportunity—and the moral duty—to see that no considerations of individual prestige or gain stand in the way of that centralisation of control which alone will bring about the developments and economies so sorely needed.

Those who are reluctant to submit themselves to a Joint Electricity Authority should bear in mind that the Act of 1919 stipulates particularly that a Joint Authority must be representative of the authorised undertakers in the district concerned. The lines of development, as foreseen by the Commissioners, would be :—Generation and main transmission would be centralised under the Joint Authority, the principal stations (forming the central supply system) being interconnected, and such new stations and main transmission lines as might be necessary being constructed when and where required to compensate for the closing of obsolete or inefficient stations and to supply new demands. Local distribution and commercial development would remain in the hands of the authorised distributors. It will be seen that with this organisation and this scheme of development, existing undertakers need not fear that they will be treated unfairly by the Joint Authority ; also, they will represent the principal customers of the Authority, and there will be no question of the latter operating a system independent of, or in competition with, those of existing undertakers.

The applications made to the Commissioners for consent to the establishment of new generating stations and the extension of existing stations, showed a marked decrease in the year 1921-22 compared with the previous year. Thus the plant capacity of stations and extensions sanctioned amounted to about 174,000 kw., compared with 697,000 kw. for the preceding fourteen months. This decrease was due partly to the general depression of industry and also to the fact that during the first fourteen months there was abnormal activity in overtaking arrears occasioned by the war. The slump is, however, a temporary one, and the Commissioners anticipate a period of great development following the resumption of more normal conditions in industry generally. For instance, the Commissioners estimate that in eight of the main electricity districts the maximum demand, compared with that of the year 1920-21, will increase 85 per cent. by 1926 and 165 per cent. by 1931. The corresponding estimated increases in units (kw.-hrs.) per annum are 97 per cent. by 1926 and 192 per cent. by 1931. These estimates, it should be noticed, are based upon normal conditions of industry and apart from the potential demands for railway electrification. The depression from which we are now emerging will doubtless postpone the date by which the above increases will be effected, but otherwise there is little reason to doubt that future developments will substantially accord with the forecast made by the promoters of schemes, and thus involve large additions to the plant capacity at present existing in the country.

Though the Commissioners' Report is belated in its appearance, referring as it does to a period which ended nearly a year ago, it will be seen that it contains the record of valuable work done by the Commissioners themselves, and holds out a well-founded promise of much brighter days for the whole of the electrical industry. We ourselves have the firmest faith in the high destiny of the electrical industry, and we appeal most earnestly to all members thereof to co-operate in every possible way for the common weal.

TELEGRAPHY.*

Being Solutions to the Questions set by the City and Guilds of London Institute at the Final Grade Examination in Telegraphy held in May, 1922.

Compiled by a Silver Medallist.

(*Continued from page* 107.)

Q. 3.—Explain with the aid of a sketch or diagram the method of connecting an overhead line to an underground line, and indicate the function of the protective devices used.

A.—At the junction of an overhead line to an underground paper core cable special precautions are necessary to prevent the access of moisture to the cable in order to maintain its high insulation. To ensure this, the following method of jointing is adopted :—The underground paper core cable is led up the terminal pole to a point about midway between the top and bottom arms, where the joint is to be made. In order to protect the cable from damage, it passes through a cast iron bend where it emerges from the ground and is enclosed within a wrought iron pipe to a distance of about 9 ft. up the pole. A lead sleeve of suitable dimensions is passed over the end of the cable and its conductors are stripped back for a certain distance of their insulating coverings and joined and soldered to the enamelled cotton-covered twin wires, enclosed in lead tubing, which emerge from one end of a cable distribution plug fixed to the back of the pole midway between the top and bottom arms. The distribution plug consists of any alloy plug cast round and through which the separate lead-covered twin core cables are led. The enamel on these wires is carefully removed by fine emery paper before jointing, and the joints are insulated with adhesive insulating tape. The lead sleeve is then slipped over the joint and soldered to the cable and plug. In the case of larger cables plumber's wiped joints are made. The alloy plug cast round the leading-off wires renders the joint airtight and watertight. The free ends of the enamelled cotton-covered wires are carried with their lead sheathing to

* Consult also "Questions and Solutions in Telegraphy and Telephony," Final Grade, by Few, 2s. 3d. post free from Electricity Office.

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the appropriate arms on the pole and are bound to a special form of terminal and leading-in insulator, whence they are connected to the open lines. The general arrangement is shown in Fig. 4. The terminal and leading-in insulator has a small chamber at the top over which a porcelain cap is screwed. A hole passes down from the chamber into the cup of the insulator and another hole passes from the chamber through the side as shown. The end of the line wire passes through this lateral hole into the chamber, while the end of the twin core cable from the distribution plug passes up through the vertical hole into the chamber. The ends of the wires are jointed and given

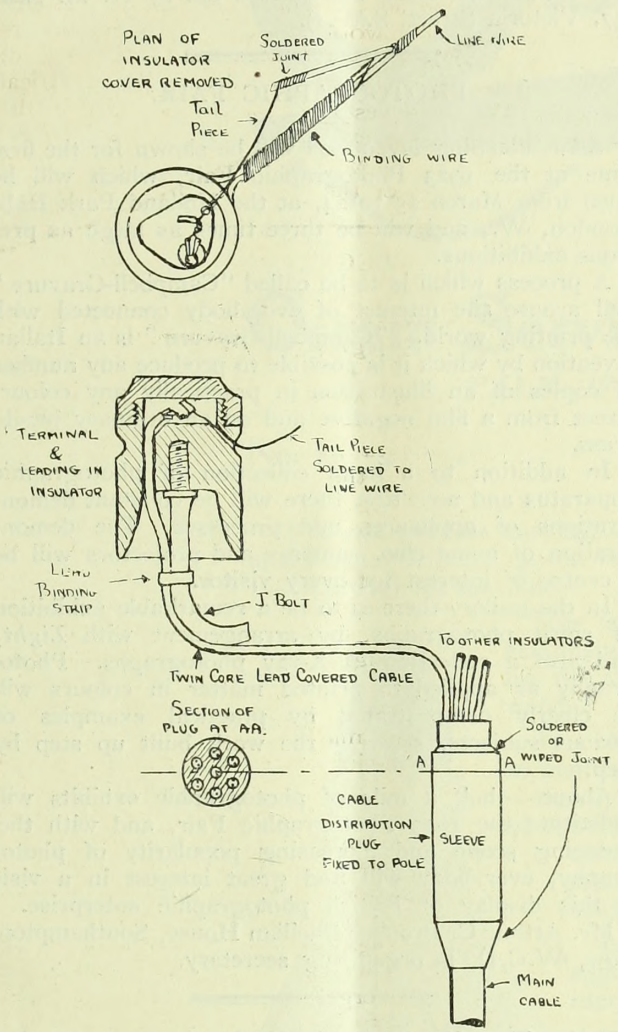


FIG. 4.

a sleeve, the chamber is filled with insulating compound and the cap screwed on. The cable leads are secured to the insulator spindle by lead binding strips. The method of terminating the overhead line wire is shown clearly in Fig. 4.

It is usual at the junction of main open and underground lines to fit pole test boxes to the pole at which the junction is made in order not only to afford testing facilities, but to carry fuses and lightning protectors to safeguard the covered wires. The fuses are inserted to prevent apparatus and lines from damage in the event of the overhead line coming into contact with a power circuit. When the current exceeds a certain limit the fuse blows, disconnecting the telegraph circuit and preventing continued contact of the underground wire with the power circuit. Lightning protectors are provided to eliminate dangers which arise from the powerful currents induced in overhead lines by lightning discharges.

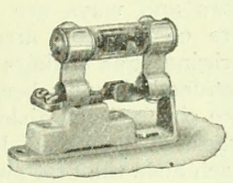
(To be continued.)

SIEMENS WIRELESS.

We have received from Siemens Brothers and Co., Ltd., Publication 460 C., and Catalogue 595. The former deals with their broadcast wireless receiver, type C.V., which is a combined crystal and single valve set, so arranged that by means of a simple changeover switch three receiving combinations are possible, viz. : (1) Crystal reception only, (2) single valve reception only, (3) crystal reception with note magnifying valve. The set, which is mounted in a polished mahogany case some 9 in. by 11 in. by 7 in., is a highly efficient combination for short-distance reception up to about 40 miles on 350 to 450 metres.

Catalogue 595 gives illustrations and particulars of telephone head sets, for which the following advantages are claimed :—Enclosed terminals, ear pieces provided with a groove to minimise condensation of moisture during prolonged wear, and special ball and socket attachment of the receiver to the headband making for comfort in wear and ready detachability. There are also illustrated various minor accessories, such as cords, aerial wire, insulators, leading-in tubes, earth plates, jacks, plugs and switches, whilst special attention is directed to the subject of aerial protection against lightning and leakages from electric power and lighting circuits.

For this purpose the firm's well-known vacuum protector, or alternatively a neat carbon block type with fuse attachment, is recommended.



For battery protection in connection with the filament accumulator, there is also an ingenious time fuse (see illustration), whereby the "listener-in," with a complete Siemens protective installation need not fear risk of damage to his apparatus, short of actual theft or accidental damage on the spot.

A special feature is also made of their dry batteries for the H.T. circuit, together with fluid Leclanché cells, dry batteries for the filament circuit of C.V. receivers, and appropriate accumulators for L.T. circuits generally.

All readers interested in broadcasting would be well advised to secure copies of these lists.

mportant Notice.—The meeting of the London Students' Section of the I.E.E. which was to have been held on March 23, has been postponed to a date to be announced later.

"Contact."—Chief place is given in the February issue to Mr. H. Marryat's recent useful and instructive paper on "Electric Lifts." Other interesting items include one on "Installation Testing Sets and their Uses," by Mr. F. T. Alldread, and one on the "Nuisance of Fuses." *Contact* is the organ of the virile National Association of Supervising Electricians, which at its recent annual general meeting presented a most satisfactory report on progress made during the past year. The meeting decided : (1) to set up an Inventions Committee to assist members having inventions relating to the industry, and (2) instructed the Board of Control to consider further the question of a special benefit section.

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A FINE EXAMPLE OF MODERN CHURCH LIGHTING.

Sixty-four years ago a new parish church was built at Stoke Newington and is known as St. Mary's New Church. Although a very fine building it fell into disrepair, and it is fortunate that sufficient funds were collected to allow of adequate restoration. At the same time the old gas lighting system was abolished and scientific, up-to-date electric lighting installed under the supervision of Mr. F. H. Taylor, consulting engineer, 19, Old Queen Street, Westminster, S.W.1.

The whole of the restoration work was effected without closing the church except for the final three weeks —the reopening taking place on the 1st inst. by the Rt. Rev. and Rt. Hon. the Lord Bishop of London, D.D., who also inaugurated the electric lighting.

Under the gas regime the average pew lighting was about 0.5 foot-candles, while now the minimum is 1.5.

Supply is taken at 480 volts D.C. three wire, the neutral being forked so that two 240-volt services are used in the building. The cables used are all C.M.A. brand, 2,500 megohm grade, supplied by Callender's Cable and Construction Co., Ltd., and are run in screwed welded conduit, carefully arranged so as to be out of sight, yet accessible at all points. The main switches are of the M.E.M. Glasgow Premier type, and the fuses M.E.M. "Kantark." The control boards are of most substantial design, and were made by J. H. Tucker and Co., Ltd., to the designs of the consulting engineer. They have nine ways, the switches being of the S.P. knife blade type for 15 amps., though the current carried is only 3 amps., so as to leave ample margin. The bases and dividing fillets (fixed) are of enamelled slate, and connections on both bars and ways are made in the front. The circuits are consistently arranged and clearly labelled. The original gas fittings for the aisle lighting have been retained, having been renovated and adapted. There are six for each aisle, and each now has four 100-watt gasfilled lamps in Holophane E 80 reflectors. For each aisle the first switch controls two lamps in fittings Nos. 1, 3 and 5, the second two lamps in fittings Nos. 2, 4 and 6, the third the remaining two lamps in fittings Nos. 1, 3 and 5, etc.

The choir is lighted by two fittings similarly controlled. The additional brackets required are in wrought iron in keeping with the old main fittings. A feature is the lighting of the chancel by four concealed 100-watt gasfilled lamps in Holophane focussing type reflectors, while the carved reredos is lighted by six 8 c.p. carbon filament, miniature pattern, lamps skilfully concealed and wired in brazed brass tube. The result is most charming and reflects credit on all concerned.

In the pulpit a special polished brass scroll, with two tubular lamps, has been provided to light the reading desk. It should have been mentioned that all the fitting work was carried out by Galsworthy, Ltd.

As the manual is at right angles to the choir, the organist has been provided with a push switch, fixed level with the lowest keyboard, which enables him to give red flash signals to the choir.

Signals are also provided to announce to the organist the entry of the choir from the vestry or by the west door—orange and blue lamps being used, with push botton control. The switches were made by A. P. Lundberg and Sons, who also supplied the tumbler switches required for incidental lighting in the church, vestries, etc. In the latter case Holophane bowl fittings are used. The lighting has been made complete by its extension, with suitable reliable controls, to the various outbuildings.

To carry current to the gate lanterns V.I.R. lead covered-in heavy gauge screwed, welded and galvanised conduit is used. The whole of the wiring and installation work was carried out by H. M. Leaf (47, Victoria Street, S.W.1).

PHOTOGRAPHIC FAIR.

Some startling inventions will be shown for the first time at the 1923 Photographic Fair, which will be open from March 15 to 24, at the Holland Park Hall, London, W., and will be three times as large as previous exhibitions.

A process which is to be called "Campbell-Gravure" will arouse the interest of everybody connected with the printing world. "Campbell-Gravure" is an Italian invention by which it is possible to produce any number of copies of an illustration in practically any colour, direct from a film negative and on an ordinary hand-press.

In addition to a huge collection of photographic apparatus and novelties, there will be constant demonstrations of appliances and processes. The demonstration of home cine. cameras and projectors will be a centre of interest for every visitor.

In the gallery there is to be a remarkable exhibition of spirit photographs, by arrangement with *Light*, and also a collection of X-ray photographs. Photography as applied to printed matter in colours will be clearly demonstrated by practical examples of various subjects, showing the work built up step by step.

About half a mile of photographic exhibits will constitute the 1923 Photographic Fair, and with the widening scope and increasing popularity of photography, everybody will find great interest in a visit to this display of British photographic enterprise.

Mr. Arthur C. Brookes (Sicilian House, Southampton Row, W.C.1) is organising secretary.

Making Hay.—Mr. R. Borlase Matthews' system of curing hay by the aid of electric fans is being received very favourably by practical agriculturists, as it is independent of the weather, and shows a saving of 25 per cent., after allowing for interest and depreciation on the plant, and the cost of the necessary power. A lecture on the subject was recently arranged by the Secretary (Mr. J. W. Sykes) of the Manchester branch of the National Farmers' Union.

Motor Ships.—It is too much to say that there is a revival in shipbuilding, but, according to the *Motor Ship*, there has recently been a very satisfactory increase in the number of orders placed for oil-engined vessels. During the past six months contracts have been fixed up for 51 ships equipped with internal-combustion machinery, totalling 371,000 tons deadweight. Of these, 16 are being built in Great Britain, and should, of course, represent a considerable amount of expenditure in electrical plant and accessories. The same issue contains an interesting article on Diesel Electric Propulsion for ships.

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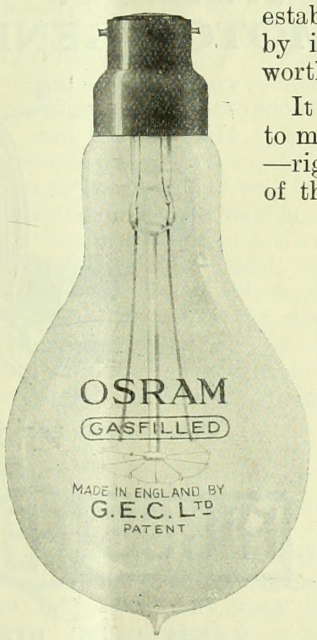
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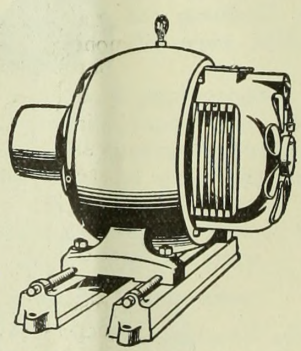
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TO OUR READERS.

ELECTRICITY is published every Friday, and, if ordered, is on sale at the principal Railway Station Bookstalls and Newsagents on that day. It has a very large sale throughout the United Kingdom, as well as in the British Colonies and Abroad.

New advertisements for the displayed columns and alterations to existing ones must reach the publishing office not later than first post Tuesday morning, in order to be in time for the issue of the following Friday. This is important. Rate quoted on application. Subscription: 13s. a year, 6s. 6d. half year, 3s. 3d. a quarter in advance, postage prepaid in the United Kingdom and abroad.

Questions to which an answer is required must be accompanied by a 1½d. stamp for reply. When considered of sufficient interest, the answer will probably appear in the paper.

All remittances payable to the Publishers, S. RENTELL AND CO., LTD., 36-39, Maiden Lane, London, W.C.2. Telephone No. 2460 Gerrard.

Current Topics.

Ratepayers *v.* Consumers.

This is a time of the year when municipal undertakings balance their books and budget for the coming year's expenditure and revenue. In their very evident desire to qualify for support at the next November elections, popularity-seeking councillors and aldermen who are members of Finance Committees, about this time throw the weight of their influence in the scale to differentiate between so-called municipal profits and corresponding legitimate claims by a certain section of the public and the ratepayers to reduced rates for electricity and reduced fares on tramways. The old, old story of so much in relief of the rates always goes down with the man in the street, who utterly fails to appreciate that in nine cases out of ten appropriations to rate relief out of the two undertakings mentioned simply mean robbing Peter to pay Paul, inasmuch as, to enable the undertaking of which he is part owner to earn a mis-called "profit," he has to pay correspondingly higher prices for his electricity consumption, or continue to pay inflated fares on the cars he uses daily.

Noteworthy pæans of joy are sounded this week in connection with Beckenham, which is to contribute £4,000 to rate relief out of its electricity undertaking; Brighton, which is mulcting local electricity consumers to the tune of £15,000; Birmingham, which is allocating £10,000 of its consumers' money to rate reduction; Newport, which is to contribute nearly £7,000; Sunderland, which legitimately pays back a debt of £6,000, borrowed from the rates in the last two years, and other municipal undertakings similarly blessed with a balance in hand which they seemingly don't know what to do with. Leicester, on the other hand, which is in the singularly happy position of being able to show a net balance of nearly £43,000 on the credit side in connection with the tramway undertaking, is very wisely allocating this sum to reserve, and not disseminating it in the form of a fractional and negligible rate reduction.

Argue as you will, there is no logical excuse for diverting money earned in excess by a municipal undertaking to general rate relief. The money is rightly due to that section of the public who have contributed to its accumulation, and, failing any need for allocation to reserve or depreciation, or even to a sinking fund, which many municipalities conveniently ignore, any and every balance should rightly go towards a reduction in the rates charged for the service which has helped to earn it. Electricity supply and tramway undertakings have felt a draught for some time past, largely owing to the exorbitant rates still being charged in the one case for electrical energy and in the other as fares. Whilst the former are waxing more prosperous it still behoves them to aim at reduced costs to the public per unit consumed, whilst so far as tramways are concerned, a very influential engineer stated the other day, in the course of a most interesting paper, that the average muncipality simply dare not tell the public the truth about its tramways and the hopeless state of their finances.

Municipal Moonshine.

Whilst on the subject of municipal electricity supply, and the apathetic indifference of some noteworthy undertakings towards the needs of new consumers, I came across an amusing example last week. In a certain city, which for obvious reason shall be nameless, the usual ponderous formalities and heavy commitments have to be gone through by every new would-be consumer before a service connection is vouchsafed or current switched on. An acquaintance of mine took a house in a leading thoroughfare and approached a firm of contractors for the fitting and wiring of his house. The contractors estimated that for the privilege of a connection to the street main he would probably have to pay at least £20 to £25, and even so might have to wait a fortnight or more until it suited the convenience of the mains department to accommodate him.

Undaunted, he gave the necessary instructions, and filled in all the complicated forms and applications as required by the very arbitrary powers that be. To his surprise as well as that of the contractors, the municipal workmen were on the scene the very next day, promptly trenched his garden path, laid a service connection, and made all neat and secure again by mid-day. Then, wonder of wonders, when the bill of costs arrived, it was for the very nominal amount of £5 only, instead of the anticipated £25. All interested were dumbfounded; they could not understand this sudden change of front and apparent desire on the part of the corporation to actually encourage the more widespread use of electricity for domestic purposes. Various explanations were advanced, but the solution came quite accidentally. A new corporation official, filling a very high position, had only just been appointed and had come to reside in the same neighbourhood; by a fortunate coincidence this municipal magnate boasted the same name as my friend, and the electricity department fondly imagined they were favouring the new man with prompt and reasonable service, a case of creating a good impression in view of favours to come. One can only hope that the man himself was treated like any ordinary new consumer before the mains department discovered their error. It should serve as an object lesson and inculcate the need for reform in that department at all events.

Telephone Development.

By way of sequel to my remarks of last week, I note that the Post Office propaganda department has been working overtime of late, and, if interviews with representatives of the daily Press are anything to go by, there is promise of progress in conversion to automatic working of some of the more important provincial exchanges in the near future. Unfortunately, in their interviews with pressmen the Post Office spokesmen fail to make due allowance for

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the fact that telephone men and engineers outside the Government are just as closely in touch with world telephone development, if not more so, than the department they represent. Thus, by the *Daily Dispatch*, Mr. Kidner, Assistant Secretary to the Post Office, is credited with the statement that "automatic equipment is very costly, and all the operators cannot be dispensed with. Only those who handle local calls may go, for operators are required to deal with trunk calls. Where there is an industrial area with several large towns all within twenty miles of each other, entailing a large amount of trunk traffic, the saving is not great."

Now, a general statement such as this discloses a certain ignorance of facts, or a wilful intent to mislead the public on the real issue. According to leading exponents of automatic telephony the Strowger system lends itself to sub-divided exchange systems, in which the actual switching equipment is located at several centres, as in the case above cited of a group of industrial towns not very widely separated. Not only is automatic telephone gear readily applicable to such a geographical distribution, treating the whole area as one from a telephonic standpoint, but there is the additional advantage that these sub-divided exchanges permit of considerable economies in cables and lines linking up the various sub-exchanges, as compared with the "trunks" of a manual system serving the same group of towns. Thus, taking such an area in industrial Lancashire, it would be possible by automatic working not only to dispense with the operators for local calls, but certain trunk operators also, and, in addition, effect considerable economies in the interconnecting cables. Surely such a general saving readily justifies the slight extra capital outlay involved by automatic equipment.

Research.

I congratulate the G.E.C. most cordially on the official opening, on Tuesday, the 27th ult., of their fine new research laboratories at Wembley. The function was a great success in every respect, and quite apart from the official speeches it is really something to be proud of to know that the great manufacturing undertakings of this country are realising more and more the value of research work in promoting trade as a whole and directly helping to individual commercial success. In this respect the G.E.C., under the shrewd guidance and control of Mr. Hirst, has been for many years an example of what proper business organisation and management should actually consist of, and I can quite imagine that the fame of the company's products will spread in a far wider circle as the years roll on. A full account of the laboratories appeared in the last issue of this paper, and I feel that my many readers can look forward with increased hope to a steady improvement in British trade; at any rate, so far as regards the electrical industry as a whole and the great G.E. works organisation in particular. Good luck to them!

Elektron.

Lubricating Oil.—Every reader who uses it should make a point of writing to the old-established Reliance Lubricating Oil Co., Ltd., 20E, Water Lane, Great Tower Street, E.C.3, and ask for prices. Mention this notice, and they will be pleased to quote.

MANCHESTER WIRELESS EXHIBITION.

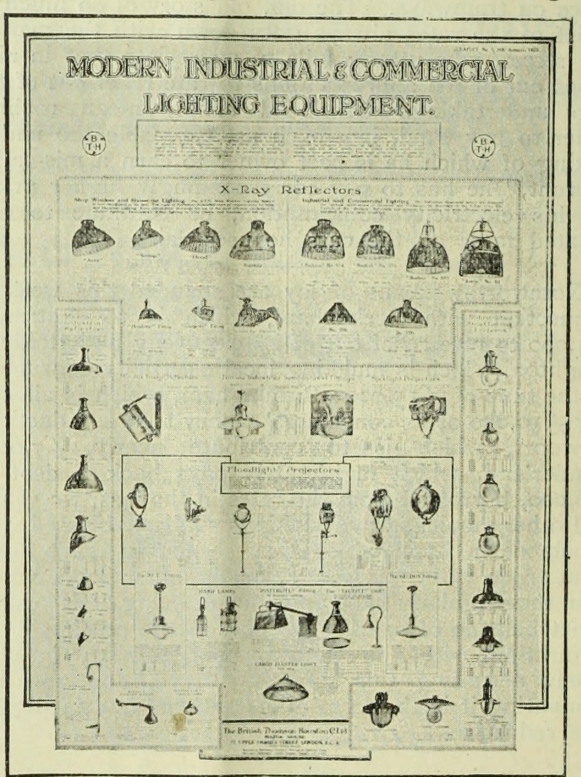
It is probably well known to many of our readers that a Wireless Exhibition is due to be held in Manchester from March 17 to March 24 inclusive, and we understand that our old friends the Chloride Electrical Storage Co. will exhibit a range of all types of Exide batteries for radio work at their stand No. 37. This will include 2, 4 and 6-volt sets, in celluloid boxes and in carrying crates, 16, 24 and 32-volt high tension sets to replace dry batteries for valve illumination.

It is worthy of notice that Exide batteries were used in the first broadcasting of grand opera and in the first transatlantic telephony.

List 4027 gives details of the various types of batteries, and will be posted free to any reader on application

"MODERN INDUSTRIAL AND COMMERCIAL LIGHTING EQUIPMENT."

The accompanying illustration represents a sheet which gives full particulars of the more important items in the B.T.-H. range of industrial and commercial lighting equipment. It measures 30 in. by 40 in., is stiffened top and bottom and provided with a cord for hanging.



It is obviously a convenient means whereby the contractor can see at a glance what is most suitable in the way of fittings and reflectors or equipment for any given job, and any contractor or engineer who applies to the Wiring Supplies Dept. of the British Thomson-Houston Co., Ltd. (77, Upper Thames Street, London, E.C.4), will, we are informed, receive a copy. The sheet is numbered L.268.

Ballybofey (Co. Donegal).—The lighting installation has been completed. Preparations are being made for an installation in the adjoining town of Stranorlar.

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MODERN STAGE LIGHTING.

THE BLACKBURN-STARLING SYSTEM.

Until recently the advancement of the art of stage lighting has not been particularly rapid, but during the last few years a fairly general improvement has been evident, while certain individual theatres have achieved marked success. Particulars, however, are generally difficult to obtain, as the installations are presumably due to the staff of, or an individual directly connected with, a particular theatre or production. We have witnessed several truly wonderful lighting effects in London theatres, the latest, perhaps, being "Decameron Nights," at the rebuilt Drury Lane.

At the King's Theatre, Edinburgh, a new lighting equipment has just recently been installed, and, as it is a standard equipment which can be obtained for, and adapted to, any theatre, we are pleased to be able to give some particulars. It is simple, convenient, easy to maintain, and highly efficient, as will be noted from the description. Known as the Blackburn-Starling system, it can be referred to in brief as a combination of three elements—the X-ray mirror reflector, the Mazda gasfilled lamp, and a metal framework to hold coloured gelatine slides. The required number of units, each consisting of a lamp, reflector and gelatine colour slide, are assembled in a specially designed metal trough.

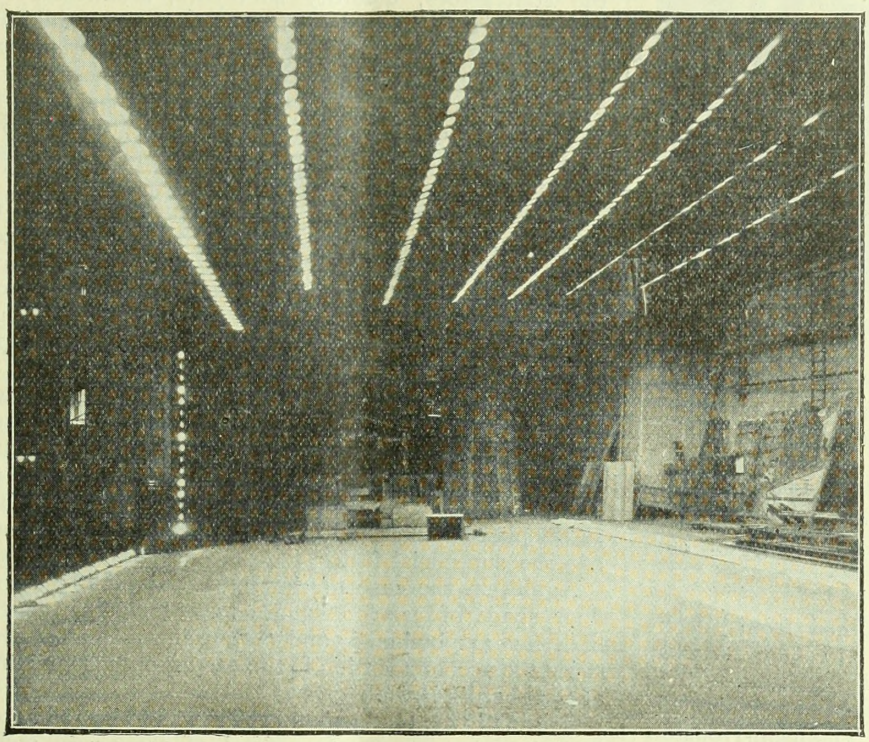


FIG. 1.

The equipment is supplied in four different patterns, viz., concentrating battens, distributing battens, floats and proscenium strips. The concentrating battens are intended for the intense illumination of particular sections of the stage. They are equipped with "Jupiter" X-ray reflectors and with 100, 200 or 300-watt Mazda gasfilled lamps. Using 100-watt lamps, this form of batten gives a downward illumination of 1,000 c.p. per lamp. That is, a batten containing thirty 100-watt lamps would project a light of 30,000 c.p. on to the stage. For the general illumination of the stage, distributing battens, equipped with "Scoop" X-ray reflectors and 100 or 60-watt Mazda gasfilled lamps, are recommended. Special "E. 60" X-ray reflectors and 60-watt gasfilled lamps are used in the float and proscenium strip. Great economy is experienced on account of the high efficiency of the reflector, and the fact that a relatively small number of standard, uncoloured, high power gasfilled lamps are used. It is computed that in many cases the installation of the Blackburn-Starling equipment may be expected to bring about increases in overall efficiency up to 200 per cent.

It should be noted that in order to change effects with coloured lamps, the producer must either keep a vast reserve of lamps already tinted, or have the lamps at present in use cleaned and redipped. In either case, the process is lengthy and expensive and inconvenient to a degree which seriously limits the producer in his search for appropriate colour effects. With the Blackburn-Starling system, however, he is able to experiment with various combinations of colours and to change from one to another almost instantaneously and entirely without expense. He can obtain colour effects which he has hitherto hardly dared dream about on account of their apparent impossibility.

The following are some details of the King's Theatre lighting equipment:—

Footlights ("float"). — Sixty-four 60-watt Mazda gasfilled lamps, in "Scoop" X-ray reflectors. The reflectors are fitted with removable colour mediums of four different colours—16 white, 16 red, 16 blue, and 16 amber. We thus obtain a tremendous variety of colour combinations simply by switching on one or more of the colours, while it only takes a few minutes to change the slides should further variations, or only one colour, be required.

Proscenium Length.—The two proscenium lengths each contain sixteen 60-watt Mazda gasfilled lamps in X-ray reflectors. The colour arrangements are the same as for the "float."

Small Battens.—There are six small battens, each fitted with forty-four 100-watt lamps—eleven of each of the four colours.

"Jupiter" Batten.—At the front of the stage a large batten is fixed, containing thirty-two (eight of each colour) 300-watt Mazda gasfilled lamps in "Jupiter" X-ray reflectors.

See Fig. 1 for disposition of the X-ray units. The photograph was taken with a very short exposure for this purpose and *not* to show the lighting effect.

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Control.—Each of the four different colours in each unit is on a separate circuit running back to the switchboard, and all lights can be "dimmed." The switchboard is an excellent example of stage electrical equipment (see Fig. 2), and is arranged for simple and fool-proof control. The circuits for the different coloured lights are identified on the board by means of coloured slates.

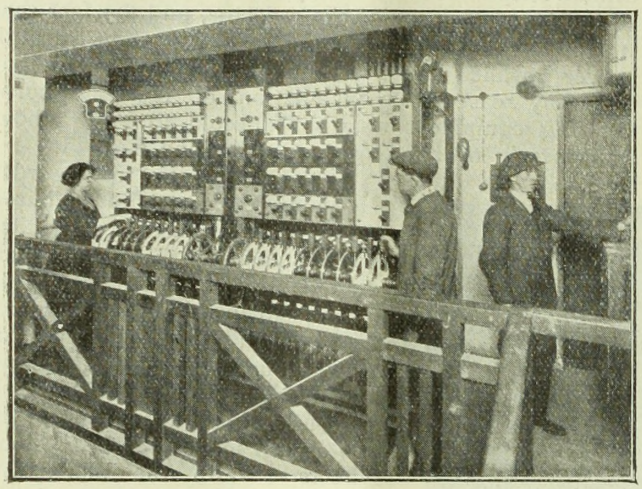


Fig. 2.

A collapsible iron gate (with lock) is fitted at each end of the gangway in front of the board, and there is also a gate in the middle to prevent persons handling both poles simultaneously.

The tracker wires at the back of the board are, in the event of breakage, prevented from touching any live terminals by sliding grill doors running on ball bearings.

Further information may be obtained from Blackburn, Starling and Co., Ltd., of Gresham Works, Nottingham, who carried out the installation. The X-ray reflectors, Mazda lamps and colour equipment used were supplied by the British Thomson-Houston Co., Ltd., 77, Upper Thames Street, E.C.4, who, we know from observation, have supplied, besides the larger equipments, similar small equipment to local halls and institutions, where, as a result, the effectiveness of the productions may be greatly enhanced. We commend the system to proprietors of these places as well as of the large legitimate theatres.

Meetings.—There will be a Wireless Night of the B'ham and District Electric Club on Friday, March 16, at 7 o'clock, at the Grand Hotel, Colmore Row, when Mr. J. Bell, of the Radio Research Dept. of Messrs. Metropolitan-Vickers, Ltd., will give a lecture on "Radio Telephony" illustrated with lantern slides and demonstrations.——The next Informal Meeting of the I.E.E. will be held in the Institution on Monday, 19th inst., at 7 p.m. Debate: "The Need for Co-operation between Manufacturer and Retailer." To be confined to the lighter electrical products, including motors, but not heavier plant and material. Constructive criticism will be cordially welcomed.——The Junior Inst. of Engineers will meet at 39, Victoria St., on Friday, 16th inst. Lecturette, "Comparative Power Costs," by C. H. Woodfield (Member). Also on Friday, 23rd inst. Lecturette, "The History and Development of the Underground Railway," by Mr. R. J. Siddall (Member). Both at 7.30 p.m.

PROGRESS OF WORK ON THE BRITISH EMPIRE EXHIBITION.

Record in Rapid Construction.

Latest official reports show that on every main section of the British Empire Exhibition at Wembley the principal contractors, Sir Robert McAlpine and Sons, Ltd., are up to scheduled time, and the progress already made on the Empire Stadium probably establishes a record in rapid construction unequalled in the annals of the British building trade.

It is important that this fact should be stated explicity in view of rumours recently circulated to the effect that "the work is a year behind." Works conferences are held every week, and are attended by the contractors, quantity surveyors, architects, civil engineers, and the general manager of the Exhibition. The various stages of the work are so clearly mapped out that any delay would reveal itself at these conferences, and so far, in all but two minor parts of the work, where delay was unavoidable, the required progress has been maintained and the contractors have been in no danger of incurring penalties.

All the foundations for the Machinery Hall and the Industrial Hall are now completed; the reinforced concrete floor is almost finished, and the railroad tracks have been laid. Many of the stanchions and reinforced concrete roof trusses have been erected, and the bulk of the steel work required to complete the superstructures has been delivered on the site.

The floor area of the Machinery Hall, which will include power house and restaurants, has been increased from the original 447,000 square feet to 588,000 square feet. This is more than double the size of the Machinery Hall at the Franco-British Exhibition held at Shepherd's Bush in 1908, when the floor space was 269,000 superficial feet.

Again, in the case of the Industrial Hall, the total floor space of 523,000 square feet—including concert hall, fine art buildings and restaurants—is more than twice the accommodation in the corresponding buildings at Shepherd's Bush.

Originally the total ground space was to be 126 acres. This has now grown to a total of 216 acres, owing in part to the big demand for space by the Dominions and Colonies, which are planning to erect their own pavilions. A new railway station in the grounds on a loop line of the Great Central Railway is being built, and the Wembley Park Station of the Metropolitan Railway is being enlarged. In all over 2,000 men are employed in connection with the Exhibition work, and it is gratifying to learn that 72 per cent. are ex-Service men.

Finance.—The directors of the County of London E.S. Co., Ltd., submit an excellent balance-sheet for 1922, in which they propose the payment of a dividend on the ordinary shares equivalent to 10 per cent. per annum and to carry forward over £48,000.——The directors of the Chelsea E.S. Co., Ltd., also submit an excellent report, and propose the payment of a dividend equivalent to 10 per cent. per annum on the ordinary shares and to carry forward over £6,000.——Messrs. Bruce, Peebles and Co., Ltd., have had a very good year, and the directors recommend a dividend of 10 per cent. on the ordinary shares with a bonus of 5 per cent. The goodwill has been written down so that it now stands at the nominal figure of £1. A truly excellent position.

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Reviews of Books, &c.

[Books noticed in this column will be sent from ELECTRICITY *Office to any part of the world, for the published price, plus ten per cent. for postage (minimum 2d.) and orders will be appreciated.]*

AUTOMOTIVE REPAIR, VOL. II.: ELECTRICAL SERVICE WORKS. By J. C. Wright. 418 pp., 164 Figs. (Chapman and Hall, 15s.)—Garage men in particular will appreciate this lucid work on the overhauling and repair of the electrical parts of modern petrol motor vehicles (Vol. I. deals with general repairs to this class of vehicle). Specially valuable features are (1) the absence of anything in the nature of padding, and (2) concise instructions for the quick carrying out of all jobs likely to be encountered. There is a wealth of carefully chosen illustrations and circuit diagrams which prove of the greatest assistance in both parts into which this volume is divided. Part I. is headed "Instruction Manual of Repair Jobs" and deals with some 56 different electrical jobs in connection with sparking plugs, coil and magneto ignition circuits, starting motor and lighting circuits, motors, generators (including rewinding), storage batteries, etc. There is also an instructive section in installing and operating a farm lighting plant. In each case there is first a list of operations necessary, then a description of the operations, preceded where necessary by the names of parts, materials, tools, etc., required or to be looked to. Finally, by the attention to a series of questions, the reader can make sure that he has thoroughly grasped the matter. A reference is also given to Part II., which deals with "Electricity as Applied to the Needs of the Electrical Service Station." This is divided into chapters devoted to a consideration of electrical and magnetic principles and their practical application in the class of apparatus and electro-dynamic machinery coming under the care of garage workers and motor vehicle owners. Shortly, it can confidently be said that the method of presentment and choice of matter and illustrations (which are excellently drawn and reproduced) is admirably calculated to meet the needs of the busy practical man who is desirous of attaining proficiency in his calling.

RADIO TELEPHONY FOR AMATEURS. By Stuart Ballantine. (Chapman and Hall. 7s. 6d. net.)—This is another book of American origin dealing with the question of radio telephony for amateurs, and in general it covers the same ground as most of the other American publications on the subject. It can be recommended to amateurs interested in radio telephony because it is practical and written on somewhat more English lines than many books emanating from the United States. It is, in fact, almost a relief to read the book and find it free from references to "ethereal messages" and "restless electrons," etc. The book covers the general principles of radio telephony, the valve and its applications, the construction and operation of transmitting and receiving apparatus, and also possesses a very interesting chapter on the sources of power for wireless circuits. In the writer's opinion, this chapter adds very considerably to the value of the book, as it is a subject which is not ordinarily dealt with, at all events not in the clear and detailed way in which the author describes the various power sources and the sifter and filter circuits necessary to their use. The chapter on aerial construction follows American practice, and as such is not of much interest to the English amateur. The information on counterpoise systems is, however, instructive. One of the interesting features the book contains is the information given, and the circuits shown, for high frequency transformer valve coupling, in which the transformers are built as small vario-couplers. The writer has not before seen this form of coupling described or illustrated, but, having experimented recently on these lines, can recommend the matter to amateur experimenters for further development. To English amateurs interested in transmitting circuits the pages and diagrams devoted to the subject will be welcome, and will no doubt give them new ideas for experimental work and test. We can recommend the book to our readers for their attention.

PRACTICAL RADIO. By Henry Smith Williams. (Funk and Wagnalls Co. 8s. 6d. net.)—On first glancing through the book one is struck by the contents, and it is difficult to decide for what particular circle of radio interest it was specially written. The opening chapter is entitled "A Wonderful Game for Boys," and the juvenile interest in the first part of the book should be particularly strong. On the other hand, when turning to the pages dealing with super-heterodyne receivers and Armstrong super-regenerative circuits, one hesitates to present a copy of the book to any member of the rising generation. Fortunately, the above-mentioned circuits are usually beyond the reach of such, otherwise we are afraid our broadcasting stations would be interfered with even more so than they are to-day. The book contains a very large amount of useful information to all those interested in the amateur side of wireless, but it is a little difficult to see quite where the field lies for a work containing such extremes of simplicity and complicity. Probably this is the make-up of the present-day American youth. Like many American books on wireless subjects, it reads almost like a novel, particularly when reading chapters on wired wireless and radio control of distant apparatus. Chapters such as these, and the information given on apparatus for transmitting pictures by radio, are merely popular descriptions, and do not give any detailed information regarding the methods used or suggested. Other matter relating to the American amateur position does not interest English readers a great deal, neither does the information on freak sets, such as crystal sets in a watch case. To summarise the book briefly, it has its good points; it is rather a mixed collection of information, and is essentially American.

MATHEMATICS FOR ENGINEERS. Part II. By W. N. Rose. 2nd edition. Cl. 8vo, 423 pp., 143 illustrations. (Chapman and Hall, 13s. 6d. net.)—We can add nothing in regard to this second edition beyond the praise which we gave to the book when it made its first welcome appearance. The few corrections which were necessary have been made and the section on "least squares" has been improved by additions relating to the determination of laws. Engineering students throughout the Empire have proved the value of the book in the past and are likely to do so even more in the future.

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The Theory of Allotropy. By A. Smits, Ph.D.; translated by J. Smeath Thomas, D.Sc. 397 pp., 8vo, 239 Figs. (Longmans, 21s. net.)—Professor Smits has here presented an able exposition of his own theory of allotropy. On page 2 is stated the fundamental postulate of phase complexity as the cause of phase allotropy, also the causation of unary behaviour by attainment of inner equilibrium. The remainder of Part I. deals with the phase equilibria of such allotropic substances, with the inner equilibrium in the case of two and of three pseudo-components, with the behaviour of tautomers in the presence of a solvent, with predictions of the theory, with a new application to electrode-potential and passivity, and, very briefly, with photochemical action and the interpretation of X-ray spectra. Part II. is an examination of the physical properties of various allotropic substances with a view to finding evidence for complexity of phase and to throwing light on the type of pseudo-system and the position of the true unary system. In addition, measurements of electrode-potential are described, which confirm in a general way the application of the theory to electromotive equilibria. It will be realised from the foregoing that the word "allotropy" is used in a specially wide sense, and, indeed, one of the charms of the theory is its general nature and applicability; it is this character which has led to the new theory of electrode-potential. This is based on an assumed solubility of the electrons freed when a metal ionises in the presence of a solution of one of its salts. It is in virtue of this and of the usual assumptions of electrostatic attraction that the equilibrium metal-electrolyte is supposed to be reached. A thermodynamical application of these ideas leads to the establishment of e.m.f. formulæ of the Nernst type, but with the "solution tension" of Nernst replaced by the "saturation concentration" of the metallic ions. Further, by a scarcely justifiable application of the law of mass action, other expressions for e.m.f. are obtained, and in these the Volta effect does not appear. These are followed by application of the theory to various equilibria, including polarisation and decomposition voltage and to the solution of metals in acids. Most of these phenomena are then considered afresh with the help of the phase rule. In Part II. the short history of passivity phenomena and the account of modern experiments, together with their bearing on the theory, form a most interesting section. There is, fortunately, a profusion of diagrams. These are in general clear, but, owing possibly to the roughness of the paper, they contain lines which are unpleasantly heavy and clumsy. The book is worthy of the fine paper and diagrams used originally for Findlay's "Phase Rule." Dr. Thomas's translation is pleasant reading despite the heaviness of the matter. Explanations of the meaning of more of the symbols used in the mathematical derivations would be helpful. This translation is more up-to-date than the latest German edition, containing as it does an account of Professor Brereton Baker's recent work, some unpublished work by the author and other matter. All interested in chemical or electrochemical theory owe a debt of gratitude to those responsible for the production of this invigorating book.

The Real South America. By C. Domville-Fife. Cl. 8vo, 299 pp., with 55 illustrations and 4 maps. (Routledge, 12s. 6d. net.)—This is a thoroughly interesting book, charmingly illustrated and written by a man of wide experience and travel who is able to express his thoughts and describe the countries through which he journeys in a manner that carries conviction to his readers. Formerly the author was the correspondent of the *Times* in South America, and he has written other works dealing with certain individual South American republics which found many appreciative buyers in this country and abroad. In the course of this book he explains how the great southern half of the new world is only developed on the coast, and that beyond the populous and busy outer fringe, with its fashionable clubs and shopping centres, there is a vast country largely unexplored, covered with mighty forest or grass-covered pampas and watered by great rivers with cataracts surpassing the Zambesi and Niagara. The natural conclusion is that to the engineer there must appear to be enormous scope in the future for the erection of great hydro-electric stations to make use of the forces of nature which are at present running idly to waste, and it is most sincerely to be hoped that those who will ultimately secure the contracts for the design, installation and control of these mighty plants will hail from Great Britain, and that the orders will also come to us. We have a splendid standing in South America. The reputations of our men for integrity and our goods for quality are unsurpassed, but we must work hard to hold our ground and, if possible, do even better. That is why enterprising engineers, merchants and intending colonists should study this book and think over the lessons it teaches. Of course, electricity is already much in evidence in the cities on the coast. The Bolivian or inland view of it as described on page 84 is distinctly amusing, but the demand is growing and will continue to grow. On page 92 reference is made to the electrically lighted Plaza of La Paz, and on page 199 Edison is quoted as having contemplated the electrical destruction of locusts by the thousand million, although the scheme has not yet materialised. The farm owners and colonists devoutly wish that it would. Electricity also bulks largely in the Panama Canal zone, which is dealt with briefly but ably, and the only criticism the writer has to make about a book which he has enjoyed most thoroughly, is that on page 194 the word "omnipotent" in line 8 seems strangely out of place. It must surely be a misprint for the word "impotent," but at present it contradicts the adjoining adjectives.

Electrical Circuits and Connections. By W. R. Bowker. Medium 8vo, cloth. 220 pp., 166 diagrams. (Lockwood, 15s. net.)—This is really the third edition of a book by Mr. Bowker which used to be known as "Dynamo, Motor and Switchboard Circuits," and as such had a fairly steady sale among installation contractors, engineers-in-charge, foremen, etc. The present work contains an additional section, dealing with rotary converters, hydro-electric lay-out, and automatic control and operation. Included therein are diagrams of the working of the Sperry gyroscope compass which are likely to interest quite a number of sea-going electrical engineers.

Elektro-Adressbuch, 1923. Cl., 800 pp. (Schulze, Leipzig. (Rentell, London. 21s. net.)—This book, of about 800 pages, is a directory of the German electrical industry, and as such it gives a good idea of the large number of firms in the Fatherland who are engaged

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in the manufacture of electrical apparatus and plant, and with whom British firms again have to compete in the markets of the world. It is now in its 10th edition, and the entries and details are given in five languages, viz.:—German, English, French, Swedish and Spanish. It is carefully sectionalised in regard to manufacturers, retailers and contractors, as well as giving lists of customers in the form of electricity stations, tramway and railway companies, and industrial undertakings. At the time of writing the price is 112,000 marks. What it will be when this notice appears in print we refuse to prophesy.

"The Wireless Handbook and Diary." By Paul D. Tyers. (Radio Press, Ltd. 2s. 6d. net.)—All wireless amateurs will welcome the "Wireless Handbook and Diary," and it is, of course, only right that such an enthusiastic section of the community should have a pocket book of their own. The notebook and diary is the usual diary for 1923, with pages for memoranda, addresses, etc. The handbook portion contains very valuable information in the way of formulæ, particulars of different types of valves, grid leaks, condensers, etc., and also very clearly illustrates the conventional signs used in wireless diagrams. A range of diagrams is also given for both receiving and transmitting circuits. These diagrams are very well and clearly drawn. The usual tables of wire gauges, particulars of resistance wire, are also included, and short notes on turns of wire and sizes to be employed for various inductive units are also given. On looking through the book, one cannot help feeling that the publishers have not gone quite far enough. For instance, quite a number of pages are devoted to London amusements, sporting notes and records, daily wants dictionary, a gardening calendar, and knowing the enthusiasm of the wireless amateur so well, one can quite appreciate that these particular pages are of no interest to him whatever. A suggestion for the future may be given regarding the insurance coupon included in the pocket book. Why not make this insurance coupon cover damage by fire or theft to the owner's wireless set? To summarise the book, it is really a standard "Letts" diary, with the addition of 42 pages of handbook matter relating to wireless. As far as it goes, the book is good, but we think the publishers could effect very considerable improvement.

The Practical Electrician's Pocket Book, 1923. 570 pp. and diary. (Rentell, 3s.).—Twenty-five years' continuous progress is exemplified in this edition of the ever-increasingly popular red-coated manual, and alterations and additions have been carefully made on the same lavish scale to which readers have become accustomed. It is now, if possible, more valuable than ever to its numerous readers. Among the sections which have been rewritten may be mentioned those devoted to steam boilers, motor control gear, portable electric tools, flexibles, railway signalling. Besides bringing the section on comparative resistances of various metals and alloys up to date, additions have been made by the inclusion of new tables, giving useful information on representative alloys going under well-known trade names. The same policy, too, has been adopted in the heating and cooking section, where the tables now added give particulars of the composition and electrical and mechanical behaviour of wires and tapes available for glowing elements. The "wiring systems" which came on the market between the appearance of the preceding edition and the time of going to press with this edition have been added to those of earlier arrival. The sections on fuses and on electric clocks have also been augmented, the valuable chapter on electric welding added to by an expert, and an entirely new chapter of wireless broadcasting inserted. Further, the useful set of central station tables now includes the commencement of a new table showing the average number of units used per annum by consumers taking supply under rateable value tariffs. This, we believe, is information nowhere else obtainable, and is distinctly useful to central station engineers. Absolute reliability is essential in any work which gains a place in the City and Guilds list of "Works of Reference," as has been done by this hardy annual, and the publishers clearly aim at maintaining that reputation to the best of their ability. The book is compact and well printed, and covers such a wide ground in a concise and practical way that no one in the whole electrical profession can afford to be without it.

A POCKET "VADE MECUM" OF TECHNICAL DATA RELATING TO ELECTRIC CABLES.

A most useful pocket book giving a mine of information on all classes of wire and cable work, particularly as has often been sought by station and power-distribution engineers and the larger contractors, has been published by W. T. Henley's Telegraph Works Co., Ltd., at the nominal price of 10s. 6d. Measuring 6¼ in. by 4 in., the work is strongly and neatly produced, and, besides 196 pp. of most valuable matter (the printing being very clear and the paper a specially selected brand), contains some pages of squared paper. We have not just glanced through this publication, but have studied it in considerable detail, with the result that we are most impressed by the vast amount of work which must have gone into its compilation, and also with the care which has been devoted to its production.

It is divided into five parts as follows:—*Part* 1 is devoted to useful formulæ and data, including tables of conductors, British standards and their metric equivalents, diameters of various types of cables, carrying capacities, electrostatic capacities, impedances, temperatures, specific gravities, melting points, etc., of various metals. *Part* 2 presents a complete copy of the B.E.S.A. Specification for insulated cables, including tables of conductors with their metric equivalents. *Part* 3 deals with underground construction; many suggestions are given dealing with the outstanding features of various systems; cables laid direct in the ground, on the solid system, drawn into ducts, erection of colliery cables, and automatic protective systems are discussed. *Part* 4—overhead construction—includes a general interpretation of the B.O.T. and P.O. requirements, general details relating to the constructions of overhead lines are given, together with tables and graphs dealing with currents on bare overhead lines, suspension strands, sags, temperature rise, etc. *Part* 5 gives a comprehensive list of all classes of cables and accessories.

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NEW M.-V. PREMISES IN BIRMINGHAM.

In Daimler House, 33-34, Paradise Street, Birmingham, the Metropolitan-Vickers Electrical Co., Ltd., have now brought together the general engineering office, supply department offices, showrooms and stores. The ground floor and basement of these premises are particularly capacious and the very excellent window frontage provides means for making a representative display of electric fittings and the various domestic and other applications of electricity. The whole is well arranged and the showroom displays are in excellent taste. In the main showroom the company have a comprehensive display of their complete range of electric fittings manufactured at their Birmingham fittings works, Harcourts, Ltd., a subsidiary of the Metropolitan-Vickers Electrical Co., Ltd. Space limitations prevent our referring in detail to the other numerous manufactures and the fine arrangements for demonstration.

We would add, however, that there is a trade counter department in the basement, where the whole of the wants of the electrical trade in accessories are catered for, and here also is a second showroom in which the more industrial applications of electricity are displayed and the requirements of the electrical trade are still further studied. An attractive exhibition is made of fractional horse-power motors, a representative section of control gear, special apparatus for the application of electricity to mining, and a complete range of fittings for workshop, factory and street lighting. The Glo-clad system of wiring, a special product of Messrs. W. T. Glover and Co., Ltd., an associate company of the Metropolitan-Vickers Electrical Co., Ltd., is adequately displayed; in fact, it may be safely said that at Daimler House the Metropolitan-Vickers Electrical Co., Ltd., are in a position to meet every requirement of the electrical industry.

Trade Notes.

No. 1 of the Sunco Monthly Price List of Electrical Supplies has just put in an appearance, and is certain to have a hearty welcome from contractors and retail dealers in electrical supplies throughout the kingdom. The list will be published regularly on the 1st of every month, and trade readers who wish to receive it should write officially to the **Sun Electrical Co., Ltd.**, at 118, Charing Cross Road, London, W.C.2, and ask to be put on the list.

Plant and Supplies, Ltd (12 and 13, Henrietta St., W.C. 2), have issued a list dealing with "One-watt and Half-watt Type Sceando Lamps." A feature is the paragraph contrasting the illumination curve obtained with the Sceando one-watt spiral filament lamps and that obtained with the ordinary straight filament type. The curves show an efficiency in the mean hemispherial basis 30 per cent. greater for the Sceando spiral filament type.

A leaflet from **Frederick Pratt** (23, Queen Anne's Gate, S.W. 1) describes and illustrates Vanwyk's (patent) overload switches, which are particularly intended for private-house installations, where they may be used to replace the service switch and cut-out, or as current limiters. The switch is somewhat on the lines of the ordinary rotary snap switch, but is provided with an electro-magnet, which, on becoming energised to a pre-determined amount, trips a pawl and causes the switch to be driven by a spring to the "off" position. Maximum current, 15 amps.

Four separate sections of the M.-V. Supply Catalogue have recently been printed, and deal in a thoroughly appropriate manner with the high-grade manufactures which are listed. The items in the various sections are as follow:—List 113/1, miscellaneous insulators for general work; List 130/1, wiring accessories; List 127/5, a set of lighting fittings for industrial and outdoor use; List 150/12, a fine selection of domestic and industrial appliances of various kinds.

We are pleased to announce that during the whole of the recent wireless telephony tests between the U.S.A. and this country "Exide" batteries (**Chloride Electrical Storage Co., Ltd.**, 219-229, Shaftesbury Avenue, W.C. 2) were exclusively used at the New Southgate works of the Western Electric Co., Ltd. An attractive poster has now been designed to illustrate this.

In descriptive list A3b (superseding list A3) **Crompton and Co., Ltd.** (Chelmsford), illustrate and describe their large polyphase induction motors. The motors dealt with are of the induction and synchronous types—the latter being of the company's patent self-starting pattern and capable of starting against two to three times full load torque or even higher. They can be designed to draw a leading current from the line at low power factor to rectify the adverse effect of lagging current, present in all systems supplying induction motors without phase-advancers. The important information about the machines in the list is as full and comprehensive as is necessary, the dimension diagrams and shipping specification being very useful.

Mr. John H. Scott, who has been with Messrs. McGeoch and Co., Ltd., Glasgow, for the last 23 years, has now commenced business on his own account at 198a, St. Vincent Street, Glasgow, and has been appointed agent in Scotland for **Messrs. Drake and Gorham Wholesale, Ltd.**, for their specialities —i.e., lamps, fires, etc. He is also offering a full range of ship fittings of the latest patterns and special designs. Extensive stocks are held on the premises for immediate execution of orders.

The Consolidated Pneumatic Tool Co., Ltd., of Egyptian House, 170, Piccadilly, London, W.1, have been appointed sole selling agents for Weldrics and Weldrines Patent Electrodes. The works for the manufacture of these electrodes, owing to a very large increase in business, has recently been removed from Scotland to a more convenient site in the London area, and is equipped with all the latest improvements for producing the above well-known electrodes."

"Home Washing" is the title of a neatly printed 12 pp. booklet issued by **J. Walton and Son (Nelson), Ltd.**, of Walverden Foundry, Nelson, Lancs. It gives a clear description of the Bell electric washer, with illustrations of the various types now on the market and instructions how to use them.

Responsible engineers interested should write to the **Metropolitan-Vickers Electrical Co., Ltd.** (Trafford Park, Manchester), for the following instructive publications:—"Turbo-Alternators" (Circular No. 1426/1): "Battery Locomotives for Service in Industrial Shunting Yards" (Circular No. 1978/1); "Horn Gap Lightning Arresters" (Circular No. 1286/1).

The January issue of the *English Electric Journal* (published by the **English Electric Co., Ltd.**, Queen's House, Kingsway, London, W.C. 2) is particularly interesting and instructive. The subjects dealt with include the Leicester Central Generating Station, Railway Electrification, Sheet Mills, the Power Plant and Electrical Installation of a Large Carpet Mill, and some notes on the "English Electric" Asynchronous-Synchronous Motor.

Magnavox Loud Speakers.—The Sterling Telephone Co. announce that the Capital Cinema, Cardiff, has been equipped exclusively with Magnavox Loud Speakers. This cinema is said to be the largest in Great Britain, having a seating capacity of over 3,000, and, owing to the efficiency of the equipment, the wireless concerts can be heard in every seat.

E.D.A. Publicity.—The E.D.A. Publicity Committee for the West Riding (Aire and Calder) Electricity Districts are preparing for a very business-like joint Press advertising campaign, and they hope that this joint business advertising will be supported with increased individual activities by the circulation of literature and publicity matter, which can be obtained from the E.D.A., at 15, Savoy Street, Strand, London, W.C.2. It should have the cordial support of all associated with our industry in that district, as it is bound to be of direct benefit in the long run.

"The Business Builder."—Part II. of this very useful magazine has just been issued. It contains several sections of interest to the electrical industry. For instance, on page 67 there are some useful paragraphs dealing with electric heating: on page 69 we find text and illustrations on the subject of electric lighting, and on page 89 the driving of factories by means of electric power is clearly explained. Also, pages 91 and 92 deal with the principles of factory lighting. Altogether, a very interesting number from an electrical standpoint.

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A POPULAR SCIENTIFIC WEEKLY JOURNAL
ELECTRICITY
A PRACTICAL TRADE JOURNAL

MARCH 23, 1923.

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DEVELOPMENT OF PUBLIC ELECTRICAL SUPPLY IN GREAT BRITAIN.

By C. H. Wordingham, C.B.E., A.K.C., Etc.

The following is a fairly full abstract of an instructive address recently given by Mr. C. H. Wordingham before the King's College Engineering Society.

Mr. Wordingham first traced the chequered development of electrical supply in this country, dealing with the class of load experienced and its influence on the size and location of generating stations. With the development of the industrial motor load, and the heating, cooking and domestic appliances load, the load factor on the station has been improved, and conditions have changed. The first big step forward occurred after the passing of the Act of 1888, which extended the period of tenure of a company undertaking electricity supply from 21 years to 42 years, and so rendered it possible to obtain a suitable return on the capital invested without necessitating an unduly inflated price for the energy supplied to the public. The earliest pioneers, with one or two exceptions, were undoubtedly the companies, but as soon as it seemed likely that profits might be made in the new industry the municipalities followed suit and entered the field.

Since then the work has been shared fairly evenly between the two classes of undertakers. With the exception of London, most of the large cities have undertaken the electricity supply business themselves, and quite a number of smaller municipal authorities have done the same. There is some difference of opinion as to whether municipal or company enterprise has yielded the better results. In favour of municipal enterprise, it may be said that the object usually in view is to give a supply at the lowest possible rates of charge without making dividends or profits for the ratepayers, while obviously the primary object of a company is to secure dividends. On the other hand, a municipal electricity committee is usually composed of men who, however laudable their objects, have, with few exceptions, no knowledge whatever of the business they are managing, whereas the directors of a company are men well versed in the business they are undertaking. Again, a municipality is much more fettered in its operations than a company. It is compelled to pay a fixed rate of interest and sinking fund on its loans, but, on the other hand, it can usually raise money at a substantially lower rate than a company can. It is not allowed the same freedom of trading as a company, it seldom feels itself free to advertise and do all the things included in the word "publicity," and it is not justified in running the same risks with the ratepayers' money as a company is with its shareholders', who, when they take up their shares, must know that there is a certain amount of risk involved which they need not take unless they choose, whereas the ratepayer has little option.

So far as the results attained are concerned, municipalities certainly do not suffer by comparison with companies, and undoubtedly they were the pioneers of low prices for power and other purposes. Municipalities were fortunate in the earlier days of the industry in attracting engineers who were extremely keen on their work, and the good results attained are to be ascribed chiefly to the energy and initiative of individual engineers who were given a free hand by their committees. It is only when a committee insists on interfering with its engineer that the worst evils of municipal ownership are operative.

Rather over twenty years ago a new feature was introduced into the electricity supply business by the formation of power companies. These companies obtained Parliamentary powers to supply over very large areas comprising whole counties or several counties. They were on an entirely different basis from the ordinary supply undertakings, inasmuch as they were not entitled, or obliged, to supply all and sundry consumers in detail for lighting and all purposes, but only large consumers who required electrical energy for motive power or other industrial purposes. Also they might supply towns "in bulk," as it was called, leaving the ordinary undertakers in these towns to distribute the supply in detail.

The fundamental idea underlying this movement was the improvement of load factor by the greater diversity obtainable in a large as compared with a small area, the increase in scale of operation enabling the advantages which I have already indicated to be attained, and the elimination of the expenses attendant on what one may call retail supply.

There was a large proportion of truth in these underlying ideas but a certain amount of fallacy, for, although the diversity of the load met with in the various zones of a large town may substantially improve the load factor on a single generating station supplying the same load, the mere stringing together of a number of precisely similar towns, all having the same characteristics of load, yields no appreciable diversity and does not improve the load factor. The only advantage that accrues is the increased scale of operation.

Again, the term "bulk supply," although it has now become fully established and is in common use, is, in fact, a misnomer. Whatever the means taken for generating the energy supplied to a given district, nothing can alter the fact that it must be generated from moment to moment as and when required, the rate of generation corresponding exactly to the rate of consumption. The introduction of a line of demarcation between the authority which generates and the

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authority which distributes is purely artificial, and does not in any way alter the conditions. The case is in no way analogous to the supply of gas or water, both of which commodities can be delivered in bulk and stored for distribution as and when required.

Practically the whole country was in the course of a few years divided up into large areas, each under the jurisdiction of a power company, and no doubt the Parliamentary Committees which passed the Power Companies Bills thought that an electrical millennium would ensue. Much of the evidence given before these Committees was entirely misleading. The emphatic distinction between power and lighting loads which was drawn implied that there was some magic in the use of electrical energy for power which put it on an entirely different footing from its use for lighting, whereas there are many power loads which have a poor load factor, and many lighting loads which have an extremely good one; it is all a question of the number of hours per day that the service is required. For example, in dealing with London, cheap electrical energy for power was held up as a vital necessity, and the question of lighting pooh-poohed. In point of fact, cheap energy for lighting is, if anything, the more important of the two in the metropolis. Cheap lighting enables dark premises, which would be practically unusable with any other form of illumination, to be brought into service and utilised as efficiently as though they were lighted by daylight. When one considers the tremendous value of floor space in the principal streets of London, one must see how vitally important to the trade of the metropolis is this use of electrical energy, and how necessary it is that it should be supplied cheaply.

When the power companies obtained their Acts, large towns, which already had an efficient supply of electrical energy, were in many instances expressly excluded from their operations. This has often been held up as a great injustice to the power companies, it being said that the valuable portion of their loads was withheld from them and only the unprofitable part left. While it is quite true that these excluded areas would probably have been of great value to the power companies, it must be borne in mind that at the time the power companies came on the scene there were already in existence highly efficient undertakings of considerable size on which large sums of capital had been expended out of public money. Take, for example, the city of Manchester. When the Lancashire Power Company went for its Bill at the end of the nineteenth century, Manchester was already supplying at that early date energy for motive power at 1¼d. per unit, and had laid out very large sums of money on its undertaking. Under its statutory obligations, the city had to supply every kind of consumer, whether profitable or not. If the power company had been given their area, the company could have taken away all their large power consumers, from whom the bulk of their revenue was derived; could have supplied them not only with power, but with light; and would have left the Manchester Corporation with only the unprofitable small and short-hour consumers, notwithstanding that their undertaking was thoroughly efficient in every way. Surely this would have been very much more unfair than declining to give to an entirely new authority the power to ruin the established undertaking. After all, in those cases in which these large cities have had their territory reserved to them, a very wide field of industrial power outside the city areas has still been left to the power companies.

Notwithstanding the promises made, the power companies failed in nearly all instances to carry out their professions. Even now, after having had their powers over twenty years, some of them are operating on the scale of a third-rate municipality. There have, however, been a few notable exceptions, and to these all honour is due, though it must be confessed that the financial results so far have not been startlingly brilliant.

What is the cause of this relative failure? Various reasons—or, perhaps, in some cases one should rather say excuses—have been advanced, but the causes are probably complex and not altogether easy to arrive at.

Whatever may have been the ultimate cause, the proximate one was certainly inability to raise the necessary capital. In many instances this could only be obtained with the help of large manufacturing companies, who were content to take a portion of the payment due to them in shares instead of cash. When payment is made in this manner it is obvious that the purchaser does not get the benefit of cut prices. One reason for this stringency of capital which is usually advanced on behalf of the power companies is the exclusion of a few of the large profitable towns from their areas, and while, no doubt, some weight should be attached to this, I cannot think that it is a sufficient explanation.

The next reason usually put forward is a somewhat vague and hazy reference to restrictive legislation. I confess that here, again, I am doubtful as to how far this can be regarded as a real cause, and, indeed, I am by no means clear as to what particular restrictions are referred to.

There must be some explanation, and in view of the fact that, to all intents and purposes, the most modern ideas on the best way of affording a cheap and abundant supply coincide with those underlying the power companies' schemes, it is important that the true reason for the non-success of these companies should be ascertained.

I believe that the fundamental reason is that the companies were before their time, and that the electricity supply business had not developed to a sufficiently advanced stage to enable them to operate on a commercially successful scale.

It is not so much that the state of the art at the time would not admit of the establishment of what we now call capital stations, though undoubtedly great advances have been made during the last twenty years in material, but that the general public, including therein the industrial section of the community, had not been educated to appreciate the potentialities of electrical energy for the cheapening of production and the betterment of the conditions of existence.

Even contrasting the attitude of the public at the beginning and termination of the war, one sees an enormous advance, and this advance is still greater if the comparison be made between the first year of this century and 1923. Electric motive power is the only kind now considered for industrial purposes when a supply can be obtained at a reasonable price, and we are on the eve of its practically universal applica-

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tion to railway transport. In the less spectacular, but hardly less important, field of shop and domestic use, electric lighting may be said to be universal, and the number of small appliances for saving labour and ministering to convenience is legion.

The effect of this education of the public mind is vastly to increase the demand both in magnitude and diversity, and the capital station now becomes justified, whereas in the earlier days of the power companies only a very meagre demand could be expected even from a very large area.

(To be continued.)

SOME TRAIN LIGHTING SYSTEMS.*

By CYRIL T. COCKS.

During the latter part of 1881 the L.B. and S.C. Rly. equipped a Pullman car on the run between London and Brighton with twelve Swan C.F. lamps, current being supplied from a battery of 32 Faure cells, each cell weighing 45½ lb. and capable of supplying light for about six hours. The battery was carried underneath the car, and had to be removed daily for recharging.

This is probably the first recorded attempt to light a rail coach electrically, and, when one remembers that both cell and lamp were at that time in their infancy, great credit is due to the company in question for their initiative.

A few months later the same company equipped a train of four Pullman cars with electric light, 29 lamps of 10 c.p. each were used, current being supplied as in the previous case.

About this period the N.B. Rly. equipped a train with electric light. A small "Brotherhood" steam engine and dynamo fixed on the locomotive were used to supply the necessary power. In 1883 the L.B. and S.C. Rly. equipped three trains with Stroudley's system, which consisted of a dynamo in the guard's van driven from one of the axles by means of a belt through the floor.

A battery of lead cells was used in conjunction with this system.

Such was its success that this company eventually equipped over twenty-two trains. Other railway companies now began to experiment with various systems of electric lighting, and with the experiments the many difficulties peculiar to railway working, which precluded the general use of any of the aforementioned systems, became obvious to all concerned. The necessity of having each coach separately equipped caused a temporary setback to this form of lighting, and for some time nothing suitable was found until, in 1894, Messrs. J. Stone and Co. patented a single battery system, followed shortly afterwards by their now well-known double battery system. Its success was immediate. It was at once adopted by many companies, the earlier ones being the G.N. Rly. of Ireland and the L.T. and S.E. Rlys.

Messrs. J. Stone and Co., of Deptford, may therefore justly be considered the pioneers of train lighting axle generator systems of the world.

* Abstracted from the *Transactions of the South African Institute of Electrical Engineers.*

Subsequently many systems were introduced, and one finds to-day separately equipped coaches common to all railways. Many trains are still equipped with systems supplying light to more than one coach, as with block train lighting the advantages of the separately equipped coaches are not apparent.

As regards South Africa, "the pioneer effort at electric lighting of trains was made at Capetown about the year 1886. This trial outfit comprised a steam engine with belt drive to a dynamo installed on a locomotive; but, as the experiment was found unsatisfactory, it was abandoned." In 1883 a straight storage battery system was tried with a certain measure of success, while in 1896 it was decided to adopt a "head end" system consisting of a Hornsby-Ackroyd oil engine of about 5 h.p., driving a dynamo by means of a belt, the latter being rated at 40 amps. 52 volts, the unit as a whole being placed in a van. "The useful service extending over many years which these engines gave fully justified their selection by Mr. John Denham, then Chief Electrical Engineer, C.G. Rly."

In 1895 the N.G. Rlys. introduced their straight storage battery system, to be followed in 1897 by the installation of Stone's double battery system, which was the first self-contained coach equipment installed in this country.

In 1903 the C.S.A.R. equipped a passenger train with Stone's system, which is now the standard adopted by the S.A. Rlys.

All train lighting systems can be classified under three heads:—

(1) Straight storage battery systems.
(2) Head end systems.
(3) Axle generator systems.

STRAIGHT STORAGE BATTERY SYSTEM.

This system consists essentially of a battery of accumulators, the usual lighting fittings, circuit controls, and a through connection for the path of current to adjacent coaches.

The general arrangement is as follows:—

A battery of accumulators is usually accommodated in the brake or guard's van, the accumulators having a capacity to suit the lamp load of an average train, say, 300 ampere hours, and being so arranged to give 50 volts potential across the lamps. A simple circuit is then led through a small distributing panel to a two- or three-point coupling, the latter being used to enable the guard to switch on half or full lights as the occasion may demand. In this case, of course, the positive lead is "split," and the lamps wired alternately, the negative forming a common return.

There are few outstanding features connected with the straight storage battery system worthy of note, but as this system is the mother of all modern systems these features must be considered.

It is of more than passing interest to note that the Administrations of the Cape and Natal Gov. Rlys., with Mr. J. Denham and Mr. F. W. Mills as their respective chief electrical engineers, had progressed a long way on the road of development of train lighting by electricity before many of our home railways had thought of starting this form of lighting, and the experience gained by the behaviour of lead cells under traffic conditions formed a great asset for subsequent development.

The drawbacks to this system both from a railway and electrical point of view are very manifest.

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First, the long periods of withdrawal of vans from traffic for the purpose of recharging cells, together with the damage done to the underframe of the van by acid, "estimated in the case of the N.G.R. at approximately £100 per van per annum."

Second, the unsatisfactory working of cells when traffic conditions necessitate their remaining in an uncharged or run down state for abnormally long periods.

Compared with other systems, the advantages of the straight storage battery system are its reliability and simplicity. There is no complicated mechanism to get out of order, and so long as the battery charge lasts there is a positive source of current.

The disadvantages are, however, far greater than the advantages, as the straight storage method requires an elaborate system of yard wiring in order to have charging facilities at all points of vantage, to assist as far as possible the traffic control in congested yards.

Further, a comparatively large generating capacity has to be installed at all terminal points. This, together with the low efficiency of the cells, renders this system both inefficient and expensive.

Head End System.

This system also is designed for block train lighting, especially for long distance trains where charging facilities are not available. It usually consists of a steam or axle driven generator and a battery of accumulators, although in many cases the latter is not included.

"Head end" is an expression implying that the lighting unit is contained in the leading end of the train.

Many useful and elaborate systems are in use in the States, being especially suitable for long distance traffic.

Such a system is employed on the Capetown-Simonstown passenger service, and consists of a type "M" Pyle National Turbo-Generator on the locomotive.

The turbine is of the double velocity stage type, and runs at a speed of 3,000 r.p.m., the machine being fitted with ball bearings throughout. A standard coach coupling is fitted to the front of the locomotive, and another to the rear of the tender, while a disconnecting coupling is accommodated between engine and tender.

A double-pole switch with fuses is provided in the cab of the locomotive for the necessary control. This system has proved eminently satisfactory and efficient, and has fulfilled a long-felt want for the class of traffic it is used upon.

The author would mention in passing that the Type "K2" Pyle National Turbo-Generator unit may be considered as a standard adopted by the S.A.R. Administration for locomotive headlights.

Axle Generator Systems.

Systems under this heading refer to separately equipped coaches. Many head end systems have axle generators.

Of the many axle generator systems that have been introduced to the railway world during the past decade, few have survived the rigorous and abnormal conditions to which they are subjected in actual practice, and fewer still have departed from the original scheme of the pioneer system. So much so that one is able to classify all axle generator systems under two heads:—

(I.) The variable speed single battery system.

(II.) The constant speed double battery system.

Although Class I. includes some double battery systems and Class II. also some single battery systems, speaking generally these headings stand correct.

In mentioning some of the better known systems, the author would apologise for passing lightly over them in order to devote more time to those systems where practical experience has been gained, thereby avoiding the mere repetition of the information afforded by the many profusely illustrated catalogues.

In choosing an axle generator system for separately equipped coaches the main factors to be considered are:—

(1) Adaptability.

(2) General efficiency.

(3) Economy.

Adaptability encourages efficient work on the part of the examining staff. The absence of intricate regulating devices is therefore a very desirable point.

Efficiency must be general, and not confined to one position only. The dynamo, for instance, may be of a comparatively low order of efficiency when considered purely as a generator, and yet that very characteristic may be the one essential to its successful inclusion in a train lighting system.

Brown Boveri System.

This system is not used in England, but is extensively used in Germany and Switzerland. It is a variable speed single battery system, with an ordinary 4-pole shunt wound generator. The regulation is such as to reduce the generator output automatically to a minimum when the battery is fully charged.

Leeds Forge System.

In this system automatic regulation is obtained by allowing the armature to move axially. The armature and commutator are mounted on a sleeve free to move on the shaft, and are driven by a pin in the shaft, working in a spiral groove or cam cut in the sleeve.

The power to rotate the generator shaft cannot alter, as the pin has a tendency to ride along the groove, and, since the shaft is fixed in its bearings, the armature is pushed out of the influence of the field poles. This is effected against the force of a regulating spring. The output of the generator can be altered by changing the pressure of the spring. A single battery, with automatic switches, is employed with this type of generator.

Leitner System.

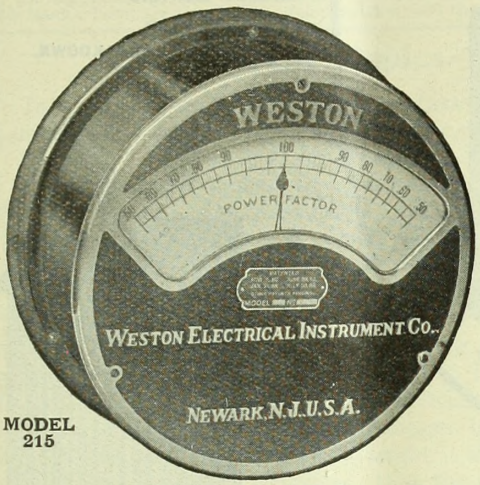
This is fairly extensively used, particularly on the G.W.R. The equipment comprises a dynamo, automatic cut-in switch, and a battery of 12 cells.

The generator has inherent properties of self-regulation. The positive and negative halves of the shunt winding instead of being continuous across the main brushes are brought to two subsidiary brushes. Flux distortion, due to alteration of speed or of armature current, alters the voltage between the subsidiary brushes, and may even reverse the sign, so that inherent regulation is obtained.

(To be continued.)

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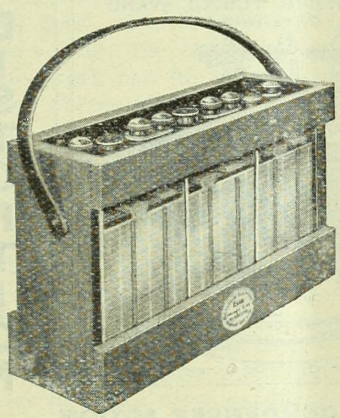
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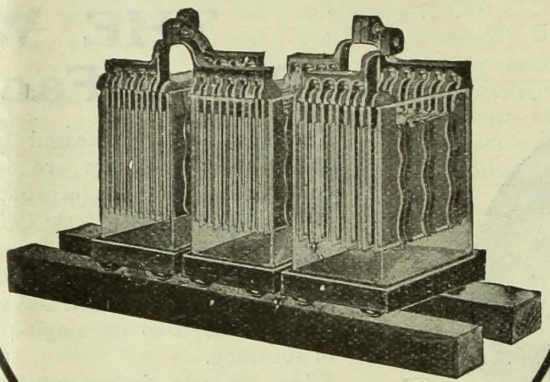
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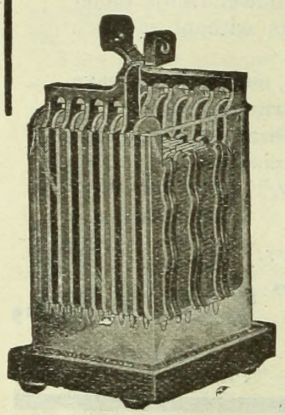
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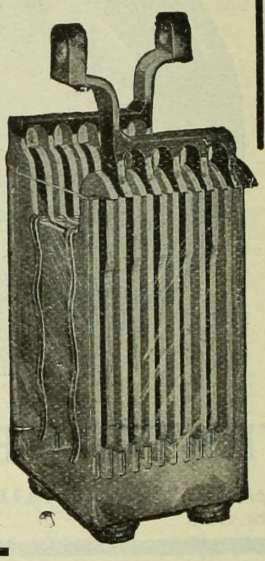
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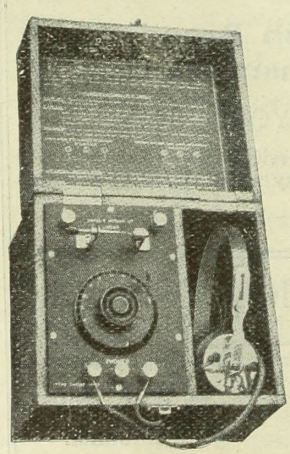
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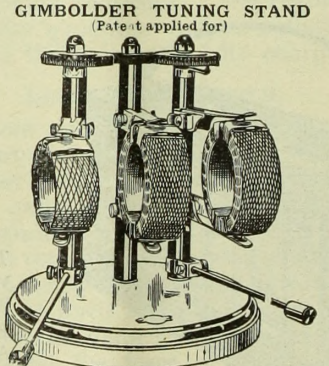
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TO OUR READERS.

ELECTRICITY is published every Friday, and, if ordered, is on sale at the principal Railway Station Bookstalls and Newsagents on that day. It has a very large sale throughout the United Kingdom, as well as in the British Colonies and Abroad.

New advertisements for the displayed columns and alterations to existing ones must reach the publishing office not later than first post Tuesday morning, in order to be in time for the issue of the following Friday. This is important. Rate quoted on application. Subscription: 13s. a year, 6s. 6d. half year, 3s. 3d. a quarter in advance, postage prepaid in the United Kingdom and abroad.

Questions to which an answer is required must be accompanied by a 1½d. stamp for reply. When considered of sufficient interest, the answer will probably appear in the paper.

All remittances payable to the Publishers, S. RENTELL AND CO., LTD., 36-39, Maiden Lane, London, W.C.2. Telephone No. 2460 Gerrard.

Current Topics.

Company Enterprise v. Municipal Apathy.

In marked contrast to the "take-it-or-leave-it" policy of many important municipal electricity undertakings, of which I quoted a humorous example last week, comes an attractive appeal to new consumers issued by an enterprising company, the Northwood Electric Light and Power Company, Ltd., of Northwood, Middlesex. It takes the form of an attractive illustrated brochure, bearing on its outer cover the slogan "The 'All Electric' House." The flyleaf urges the reader to use electricity, and in a foreword by the engineer and manager he courteously informs the public that his department is always at their service in all matters electrical; that the company particularly wish to receive inquiries regarding proposed installations or the improvement of existing installations; and, in short, "if you contemplate the use of electricity, if you already use electricity, or if you desire to extend the use of electricity, consult us."

Then follow several excellent illustrations of electric light fittings, electric irons and kettles, electric fires, some notes on electric cooking, electric fans, and last, but not least, electric vacuum cleaners. Apropos of electric wiring, the brochure is careful to point out that this work can be carried out without damage to walls or decorations and with a minimum of inconvenience. In the matter of negotiating for a supply, the company also inform the prospective consumer exactly what steps to take, and offer the assistance of their engineer in completing the details required with each application. Finally, back-cover space is not wasted, for the booklet bears this very apt quotation: "The greatest asset in the world is thoroughness. Empires have died for the lack of it. Leaders in Statecraft have failed because they forgot it. Businesses have crumbled because they spurned it." If there is room for criticism of so excellent and praiseworthy an attempt to help the good cause, it is that the publishers have thought fit to boost American irons and kettles, whereas there are far better quality and higher efficiency British electric heating appliances already on the market and giving widespread satisfaction.

Broadcasting and the Trade.

I note from the daily Press that the Electrical Importers' and Traders' Association, supported by the British Radio Manufacturers' and Traders' Association, are taking up the case of the smaller manufacturers of wireless equipment, who claim that the radio public are paying too heavily for their sets in royalties to the British Broadcasting Company. The secretary of the first-named association is also credited with the statement that there was widespread indignation in the trade at the present scale of payments, and, as a result, only about 400 out of 5,000 eligible manufacturers had so far applied for shares in the B.B.C. With due deference to the interests these two bodies have at heart, they seem to have overlooked the fact that the continued success and popularity of broadcasting is entirely dependent upon the maintenance of a transmission service of high standard such as will attract the public and promote the free purchase of sets. Without such a service, the broadcasting boom would speedily become moribund, and soon fizzle out altogether. A high-class broadcasting programme and continued trade in broadcast receiving apparatus are interdependent, a fact which is apparently ignored by those who clamour for ultra cheapness.

Even under existing arrangements, with "approved" apparatus paying its contribution towards the general entertainment of thousands of listeners-in, there is still a very large percentage of the population using home-made sets, who derive equivalent entertainment for the mere payment of a nominal experimental licence fee, scarcely an equitable arrangement. Moreover, the title of one at least of the protecting associations suggests some small interest in apparatus manufactured outside the British Isles, and which is taboo for the first two years of broadcasting under the pledge of H.M. Postmaster-General. Again, I very much question the existence of so high a complement as 5,000 "eligible" manufacturers of broadcast receiving apparatus. Admittedly, there are many small jobbers doing assembly work, and perhaps producing sets of a kind, but not the grade of apparatus which the public needs for really efficient reception. I believe I am correct in stating that the National Association of Radio Manufacturers is the parent and truly representative association of the radio trade, and that its membership roll includes the names of practically all the best-known manufacturers of reputable apparatus.

Some Revolutionary Doctrines.

In two recent papers, read respectively before the Bradford and Chelmsford Engineering Societies, Mr. A. Hugh Seabrook, M.I.E.E., a director of Sir Charles Bright and Partners, Ltd., and of the Western Electric Distributing Corporation, Ltd., advanced some arguments which, although contrary to immediate practice in the generating and distributing field, nevertheless give one furiously to think. Mr. Seabrook is an engineer of considerable experience, whose name will be familiar to my readers, and his opinions are therefore worth consideration. To those extremists who aim at the complete displacement of gas by electricity he urges mature consideration of the problem of producing the essential commodities that are the results of gas production, and are national requirements of the chemical, agricultural and other industries. For the supply of scattered districts with electric power, Mr. Seabrook advocates a combined gas and electricity undertaking. By generating electricity at the gasworks we are not

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destroying raw coal, we are certainly not creating a nuisance; we are employing the highest thermal efficiency plant it is possible to get, viz., 15,000 b.t.u. per kw. hour, as compared with 25,000 or 30,000 required by steam plant, and we are increasing the production of valuable by-products from coal.

As regards the savings to be effected by the combination of gas and electricity undertakings, these are almost too obvious to need detailing. In the first place, very little increase to the existing labour employed at the gasworks is required by the addition of a gas engine driven electricity station, the site costs nothing, there is almost invariably a natural water supply on the site, and there is an existing staff for accounts, meter reading, stores, purchasing, repairs, and so on. Mr. Seabrook estimates that the management and general charges in respect of a combined gas and electricity undertaking are only from 60 to 70 per cent. of the same charges incurred by two separate and distinct undertakings. The incidental advantage of combination with gas is that we can start from the very beginning with an A.C. supply, because, with men on the spot day and night, and gasholders for storage, we do not require storage batteries, and consequently we avoid the limitations of the D.C. station.

Another unorthodox advocacy by Mr. Seabrook is single-phase current for these schemes, his arguments in favour being simplicity of plant and mains and the lowest possible cost of maintenance and attendance, there being practically no hand regulation, and certainly no balancing, required. Also, the modern single-phase motor can be run at unity power factor. On this question of power factor Mr. Seabrook states that he is adopting another principle that many critics will probably class as hopelessly out of date and altogether wrong, viz., charging for current as metered by ampere-hour meters. In these small systems we cannot afford to have the mains and plant loaded up with idle current which is not paid for. When he is charged in terms of ampere-hours the consumer can, if he wishes, purchase motors which will use all the amperes he pays for, but, if he does not wish to pay the small increased cost of such motors, but put in the standard induction motor, he must pay the supply undertaking for amperes that he takes but does not use.

The B.E.A.M.A. Dinner—

I can certainly congratulate the members of the Beama in general, and Mr. Dunlop, the director, in particular, on the all-round success of the annual dinner on the 15th inst. The Earl of Derby, as president, was in the chair, and he was supported by most of the leading lights in our great industry, as well as by a big crowd of what I suppose I might call the rank and file, although, as a matter of fact, they represented by far the greater volume of the trade. The room was packed, and the acoustic properties are not of the best, so it was a trifle difficult to hear all the speeches; but I can say that the tone was decidedly optimistic, and I think most of us went home with the fixed idea that a good time was coming, and that in the not far distant future.

Mr. Longbottom, of Electromotors, Ltd., who is the chairman of the council, proposed Lord Derby's health in a brief but very able speech, and Lord Derby opened his reply in a decidedly humorous vein, after which he announced that, later in the year, the members of the association could look forward to the pleasure of having H.R.H. the Prince of Wales as their guest, and he read a letter to this effect from H.R.H.'s secretary. Needless to say the letter was received with hearty applause, because we all know the keen interest the Prince takes in the prosperity of the great Empire Exhibition, due to be held at Wembley in 1924, and I am confident that all connected with our great industry will do everything in their power to support him in making the undertaking a huge success.

Sir James Stevenson, vice-chairman of the executive council of the Exhibition, proposed "The Industry," which he opined was about to embark on a new and yet more prosperous era, for which hopeful wish Mr. P. J. Pybus returned due thanks; and the Earl of Derby then proposed "The Guests" in a speech which dealt humorously with the claims of Lancashire as a county famed for turning out men of outstanding ability and enterprise, and then went on to extol the virtues of the British race as the great colonising nation of the world. One main point in Empire development was its advantage for trade, so that we should be dependent on ourselves and not upon others. Therefore, we appreciate the encouragement given to British emigrants by our great Dominions. From them will spring a great and sturdy growth of Britishers who will form a market for our goods and furnish us with their goods and raw materials in return. Excellent replies were given by Sir Joseph Cook, the High Commissioner for Australia, and Sir Richard Glazebrook, while an extra toast, wishing success to Sir James Stevenson, was drunk with musical honours. Altogether it was a most successful evening.

—and the E.D.A. Luncheon.

Many of the members of our profession and industry who were at the Beama dinner met again on Friday, 16th inst., when Mr. W. B. Woodhouse, as president of the Electrical Development Association, entertained Viscount Haldane, Sir G. C. Hamilton, M.P., Sir Edward Manville, M.P., and other distinguished guests to an enjoyable luncheon at the Hotel Cecil. On this occasion the toast of "The Electrical Industry" was proposed by Viscount Haldane, and I gather from those who were near enough to hear his speech without difficulty that it was really a most eloquent discourse, in which he referred to the ever-growing dependence of our industry on scientific knowledge, and on our instruction of the public generally as to the immense services which electricity could render to the community. "It is not true," said Lord Haldane, "that labour creates wealth. It is the mind that creates wealth, and the electrical industry is establishing the domination of mind in the production of the wealth of the earth, but there is a very imperfect understanding as to where lies the advantage of electrical power."

I wonder what some of the Labour leaders think of the above quotation. It must make many of them feel

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that it is a flat contradiction of their speeches in various parts of the country when they have tried to prove that the manual labourer is the one and only class that has any real right to a place on this poor earth of ours. At any rate, Lord Haldane thinks that the electrical industry will develop enormously as soon as the manufacturing world realises that they can be supplied with electrical power at a fraction of the cost which the wasteful process of the steam engine involves, and as soon as the skilled workmen realise how immensely improved their position will be if there is an abundance of electrical power in this country.

Mr. W. B. Woodhouse, who responded, stated that he was hopeful of a steady flow of capital into the industry as soon as there was a more general appreciation of the fact that it was essential to the well-being of the country, and looked to a demand for plant and supplies which would overwhelm our present output capacity unless it was rapidly expanded. Then Mr. Ll. B. Atkinson, the chairman of the association, proposed "Our Guests," and told us that, whereas it had taken forty years to arrive at the present consumption of electric power in this country, the Electricity Commissioners believed that by the end of 1926 the figure would be approximately double that of 1921.

Sir Kenneth W. Goadby replied in a most interesting speech, in which he alluded to the enormous value of electricity to the medical profession, more especially in connection with the subject of recording accurate measurements, and I am certain that quite a lot of us went away feeling that the electrical industry is approaching rapidly to a real good time, when the columns of the trade papers will be filled with "situations vacant," and the voice of the paid agitator, whose livelihood it is to make trouble, will no longer be heard in the land.

The Play's the Thing.

The inroads made by the cinema on the legitimate theatre audiences are in a fair way to being arrested by the very successful efforts which are being made to impart an improved air of realism to the stage. This is being effected in many ways, particularly, perhaps, by attention to lighting effects. Ordinary lighting effects have been vastly improved in recent years, with the result that truly wonderful stage pictures are now almost regarded as commonplace, but the latest achievement is undoubtedly the Schwabe-Hasait system, the sole rights for the United Kingdom and British Colonies being vested in the General Electric Co., Ltd., with whom is associated Mr. Basil Dean, managing director of ReandeaN, Ltd.

I recently had the pleasure of witnessing a demonstration at the St. Martin's Theatre, and noted, in addition to various motor-controlled auxiliary lighting for general and special stage illumination, graduated and entirely controlled by one operator, the extraordinarily beautiful sky effects on the specially prepared back sheet, known as the "artificial horizon." Daybreak, sunset, moving clouds, the gathering storm, the actual storm (with lightning and rain), being reproduced with faithfulness by means of suitably housed huge candle-power gasfilled lamps, motor controlled shutters, colour screens and slides—all done by one operator. What a saving in labour, scenery and space! Obviously the system can be developed much further, as there is no need to restrict the pictures to reproductions of Nature's phenomena, and, intelligently used as an accessory to the living actors and actresses, what a pull the stage gets over the mute cinema, with its absences of true colour effects.

In the capable hands of Mr. Basil Dean, on behalf of the producing interests, and the G.E.C., with their accumulated illuminating and general engineering experience, and the Wembley Research Laboratories for experimental work and development, I foresee hitherto undreamt of possibilities for the stage. The Play's the Thing.

The Projection of Light.

The discussion of this special field of lighting before the Illuminating Engineering Society recently was interesting as an illustration of one optical problem that has so far been only very imperfectly solved. While one may assume that in some branches of work, flood lighting, for instance, the efficiency is fairly good, it is well known that the projection of pictures by lantern or kinema is attended by great loss of light. The tests of the authors (Mr. W. J. Jones and Mr. E. A. Marx, Jr.) suggested that in the average optical lantern not more than 6 per cent. of the light from the source is usefully applied. In the kinema projector the percentage of light reaching the screen is even less. Here, therefore, is a fruitful field for the ingenuity of illuminating engineers.

A Modern Franklin?

A Hungarian engineer of comparatively tender years is credited with an invention for extracting free electricity from the atmosphere in sufficient bulk to light several houses. The chief feature of the installation is a mast similar to those used for the support of wireless aerials, and the electrical energy collected is said to vary according to the height of the mast. The inventor's estimate is that it would be possible to tap a pressure of 40,000 volts at an altitude of 900 feet. During the present experiments it has been observed that the current is strongest at noon and weakest at midnight, an unfortunate coincidence if the energy is to be generally applied for lighting purposes. It does not do to appear too sceptical in these times of ultra-rapid scientific discovery, but I notice that the comments of several eminent scientists whose opinion has been sought are very guarded on the subject of this modern Franklin's alleged discovery.

ELEKTRON.

Belgium.—The report on the Economic and Financial Conditions of Belgium has just been issued by the D.O.T. (2s. 6d. net, or 2s. 9d. post free, from ELECTRICITY Office). It gives much information of direct value to English exporters of electrical plant and apparatus, and should help them to increase our already very important trade in these goods with Belgium and also with the Grand Duchy of Luxemburg.

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THE PROJECTION OF LIGHT.

At the meeting of the Illuminating Engineering Society on February 20, a paper on the above subject was read by Mr. W. J. Jones and Mr. E. A. Marx, Jr. The authors dealt mainly with the operation of optical lanterns and kinema projectors, pointing out the inefficiency of such apparatus and the very small percentage of light that actually reaches the screen. From a series of tests conducted with optical lanterns it would appear that in general the proportion of the original light usefully employed does not exceed 5 per cent. In the kinema projector it may be conjectured that the results are even less efficient. It must also be remembered that not even all the light that strikes the screen is usefully applied, since much of it is reflected on to walls and ceilings, and never reaches the eyes of the audience. Somewhat better results can be obtained, so far as those immediately in front of the picture are concerned, by using semi-polished screens of powdered aluminium, etc. But the brightness of the picture as seen from the side is correspondingly reduced; hence this type of screen is best suited to relatively narrow halls.

Attempts have recently been made to apply gasfilled incandescent filaments to projection work, and the authors gave the results of some favourable experience with special lamps of this type. Apparently there is no great gain in increasing candle-power beyond a certain limit; brightness of filament is the main factor. Thus 400 w. lamps proved practically as good as 1,000 w. lamps for this purpose.

Another interesting point commented upon was the effect of stray light in the cinema theatre. If a material amount of light strikes the screen the definition of the image is impaired, but it has been found that by suitably arranging the distribution of illumination in a theatre (greatest at the back and diminishing to zero near the screen), subdued general lighting can be provided without prejudicing the display of pictures. Provided this can be done the use of such subdued general lighting is advantageous, as an extreme contrast between the brightness of the screen and the surroundings is trying to vision.

In the concluding portion of the paper reference was made to other projection problems, such as the use of light in aerial navigation, searchlights, motor-car headlights, etc. Concealed lighting of outdoor advertisements, of which many examples have recently been provided in London, and flood lighting also offer a field for the skill of the illuminating engineer.

In the discussion one of the most interesting items was the demonstration, by Major Adrian Klein, of a model of his colour-projector that has recently been applied to spectacular lighting on the stage. The chief feature of the apparatus is that, instead of coloured filters being used, the light is broken up by a chain of prisms, so that actual pure spectrum colours are used. Mr. Justus Eck showed several new types of arc projectors, including a three-phase arc which appears to have promising qualities for use on A.C. circuits.

Several members of the Optical Society who were present also made useful contributions to the discussion, and in conclusion the chairman (Mr. Haydn T. Harrison) announced that the next meeting would take place on Tuesday, March 27, when a discussion on "Window Design and the Predetermination of Daylight Illumination" would be opened by Mr. P. J. Waldram.

TELEGRAPHY.*

Being Solutions to the Questions set by the City and Guilds of London Institute at the Final Grade Examination in Telegraphy held in May, 1922.

COMPILED BY A SILVER MEDALLIST.

(*Continued from page* 133)

Q. 4.—A submarine cable, 2,000 miles long, having a conductor resistance of 6 ohms per mile and a capacity of 0.3 microfarads per mile, is capable of working at a speed of 20 words per minute. What will be the working speed of a submarine cable 1,500 miles long, having a conductor resistance of 2 ohms per mile and a capacity of 0.4 microfarads per mile?

A.—The working speed of a submarine cable varies inversely as the product of the total capacity and the total conductor resistance of the cable. Thus, if S_1 is the speed in words per minute in a cable, the total resistance of which is R_1 ohms and total capacity K_1 microfarads, while S_2 is the speed in another cable of similar type, whose total resistance is R_2 ohms and total capacity K_2 microfarads, then

$$\frac{S_1}{S_2} = \frac{K_2 R_2}{K_1 R_1} \quad \ldots\ldots\ldots\ldots \quad (1)$$

This relationship is usually referred to as the *KR Law* and was first enunciated by Lord Kelvin.

The law is only true for cables worked under similar conditions as regards apparatus and battery power.

Now, if L_1 and L_2 are the lengths in miles of the two cables, k_1, k_2 the capacities per mile, and r_1, r_2 the resistances per mile, respectively, then—

$$K_2 R_2 = k_2 \times L_2 \times r_2 \times L_2 = k_2 r_2 L_2^2$$
$$\text{and} \quad K_1 R_1 = k_1 \times L_1 \times r_1 \times L_1 = k_1 r_1 L_1^2$$

Hence, equation (1) may be written

$$\frac{S_1}{S_2} = \frac{k_2 r_2 L_2^2}{k_1 r_1 L_1^2}$$

$$\text{or} \quad S_2 = \frac{S_1 k_1 r_1 L_1^2}{k_2 r_2 L_2^2} \quad \ldots\ldots\ldots\ldots \quad (2)$$

In the question, $S_1 = 20$, $k_1 = .3$, $r_1 = 6$, $L_1 = 2{,}000$
$k_2 = .4$, $r_2 = 2$, $L_2 = 1{,}500$

and it is required to find S_2.

Substituting the above values in equation (2) there results—

$$S_2 = \frac{20 \times .3 \times 6 \times 2{,}000 \times 2{,}000}{.4 \times 2 \times 1{,}500 \times 1{,}500} = 80 \textit{ words per minute.}$$

(*To be continued.*)

Finance.—The report of the directors of the Bournemouth and Poole E.S. Co., Ltd., for the year 1922 shows a very satisfactory state of affairs, and will permit of a dividend equivalent to 10 per cent. per annum on the ordinary shares and over £9,000 to be carried forward.

* Consult also "Questions and Solutions in Telegraphy and Telephony," Final Grade, by Few, 2s. 3d. post free from ELECTRICITY Office.

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THE "GECOPHONE" FOUR-VALVE CABINET SET.

The central feature on the G.E.C. stand in the Wireless Section of the Ideal Home Exhibition was the "Gecophone" four-valve cabinet model de luxe, with self-contained loud speaker. In designing this set, the G.E.C. have retained the simplicity of operation and freedom from technical complications which characterises all the "Gecophone" range of apparatus.

Access to the valves and controls is obtained by opening the hinged lid at the top of the cabinet, thus disclosing the ebonite panel upon which are mounted the four valves and tuning arrangements. The valves are arranged to give one stage of high-frequency amplification, followed by the detector valve and two valves acting as low-frequency amplifiers. The interior of the case contains a loud speaker of special design to give perfect reproduction and volume without distortion. Two hinged doors close the loud speaker opening when not in use. High and low tension batteries are also contained in the case, and the equipment includes four sets of headphones, which are accommodated in special compartments in the front of the cabinet.

The set will operate with the loud speaker up to within 10 miles of a broadcasing station on a frame aerial, or within 150 to 200 miles of a broadcasting station with a standard Post Office aerial, and a complete set of loading coils and reactance coils is included, rendering it suitable for receiving on any wave length.

We have received from the G.E.C. a copy of an advance leaflet, No. BC.2948, describing this cabinet "Gecophone," and we understand that copies, and also quotations, can be obtained on application from Magnet House, Kingsway, or from any of the Company's numerous branches.

TO RESTORE A LIGHTING SYSTEM.

The following four recommendations (from the *Journal of the American I.E.E.*) are at once simple and practical. By putting them into effect the efficiency of any lighting installation will at once be improved. 1. Wash reflectors and lamps thoroughly with soap and water at least every third or fourth cleaning period. 2. Fill empty sockets and replace burned-out and blackened lamps with new ones of the correct size and proper voltage rating. The voltage rating of the lamp should be at least no higher than the voltage at the socket when the system is in use. Avail yourself of the services of the lamp manufacturer in determining what the voltage rating of your lamp should be. 3 Refinish ceiling and high side walls in white or in a very light cream colour. 4. Make some reliable employee responsible for the maintenance of the lighting system and give him sufficient authority to enable him to get the work done.

Italy.—The report on the commercial and economic situation in Italy to December, 1922, has just been issued by the Dept. of Overseas Trade, and may be obtained through any bookseller, price 2s., or 2s. 3d. post free from ELECTRICITY Office. It contains much interesting information in regard to trade conditions in Italy, and should be of value to all electrical manufacturers, factors and merchants who wish to build up an export trade with that country.

NEW HART ACCUMULATOR PREMISES IN MANCHESTER.

The Hart Accumulator Co., Ltd., of Stratford, London, have recently opened additional premises at 88, Chapel Street (near Blackfriars Street), Manchester, the general view of which is shown in the accompanying illustration.



From this central position all the business in the Lancashire and district area will be handled, although their former offices and stores at 4, Victoria Bridge are being retained as a stores and repair depôt.

Arrangements have also been made at the new address, Caxton Hall, for a special technical department, where prospective purchasers can secure expert advice as to the most suitable type of battery for any special form of electrical service.

In addition to large power station and country house batteries for home and abroad, all classes of batteries for motor-car starting and lighting, yacht, telephone and telegraph work, medical purposes, etc., are manufactured at the company's works at Stratford, London, E. The present enormous demand for the smaller type of portable "Hart" batteries for H.T. and L.T. radio work has added to the ever-increasing list of Hart battery users.

High-speed Wireless at Sea.—High-speed automatic receiving apparatus has now been added to the plant on the liner *Majestic* in order to facilitate the handling of the ever-increasing quantity of wireless messages dealt with by this vessel.

Personal.—Mr. J. A. Robertson, M.I.E.E., M.I.Mech.E., consulting engineer, of Brazennose Street, Manchester, was entertained to dinner on Friday, the 9th inst., by the Electricity Committee of the Salford Corpn. on the occasion of his retirement from the post of borough electrical engineer. The Mayor of Salford presented to Mr. Robertson, on behalf of the Committee, an illuminated address of appreciation of his services during the past nine years, during which time he entirely reorganised and modernised the electricity undertaking, resulting in greatly increased output and decreased working costs. Mr. Robertson is retiring from his appointment in order to continue his profession in a consultative capacity. He will continue to act as consulting engineer for the super-power station which is being erected by the Salford Corpn. at Agecroft. He is also acting as consulting engineer in connection with the Ribble power station being erected by the Preston Corpn.

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Various Items.

"**Modern Gauging Systems.**"—A meeting of the Inst. of Production Engineers will be held at 7.30 p.m., on Friday, March 23, at the Engineers' Club, Coventry Street, London, W.1, when Mr. Axel Wickman, of Messrs. Alfred Herbert, Ltd., will deliver a paper on this subject. All interested are invited to attend, whether members of the Inst. or not, and no tickets are necessary.

Summer Meeting.—A summer meeting of the North-West Centre of the I.E.E. will be held in Manchester and Liverpool districts from June 5 to June 8 inclusive. Ladies are cordially invited, and, judging from the estimated cost, it should represent a very moderate outlay. Full particulars may be obtained on application to Mr. P. F. Rowell, Secretary, at the Institution offices, and should be asked for at once in order to avoid delay.

East of Scotland Electricity District.—The Electricity Commissioners have just issued a lengthy report of the conclusions which they have arrived at after considering the evidence given at the inquiry held by them at Edinburgh in December, 1922. They have decided to prepare a draft order giving effect to their conclusions, and the observations of the parties represented at the recent inquiry will be invited on the various clauses of the draft order before a further inquiry is held.

Catalogues Wanted.—Priced catalogues of all goods required in connection with the building and engineering trade (including electrical plant and apparatus of all kinds) are required by two Government offices—namely, the Director of Public Works, P.W. Dept., Head Office, Nairobi; and H.M. Trade Commissioner (P.O. Box 220), Bonia Building, Government Road, Nairobi. We are certain that these applications will receive prompt attention from all enterprising British electrical firms.

Meetings.—The Junior Inst. of Engineers will meet at 39, Victoria St., S.W. 1, on Friday, 23rd inst. Lecturette, "The History and Development of the Underground Railway," by Mr. K. J. Siddall (Member). Also on Friday, April 6, at the Cannon Street Hotel, annual dance. Reception 6.30, dancing commencing at 7 o'clock. And on Friday, April 13, Paper, "Instrument Equipment of Aeroplanes," by C. B. Clapham, B.Sc. (Member). Slides and exhibits. Meetings at 7.30 p.m.

Mackay Cable Companies.—Some interesting items of news were announced by Mr. Clarence A. Mackay, the President of the Commercial Cable Co., at the annual meeting at Boston, Mass., on February 15 last. For instance, with reference to the competition between cable companies and wireless, he stated his firm conviction that the latter will never be the equal of the submarine cable in responding to the exacting and fundamental demands for secrecy, speed, reliability and directness of the great volume of daily commercial business. Also he referred to the introduction of a new system of multiplex printing telegraphy, which is deemed superior to any heretofore used in any part of the world.

A Week's Rush.—Mr. Marryat, the President of the Electrical Contractors' Association, recently had a very busy week. On the 6th inst., in company with the General Secretary (Mr. Tate) he was present at a very large meeting of contractors held in Bournemouth. On the 8th he was received by the contractors of Barrow-in-Furness, and on the 9th he was at Liverpool, when the E.C.A. members, together with the manufacturers and factors, entertained him to a "hotpot." Congeniality and good feeling between different sections of the industry were much in evidence.

Overseas Trade.—The Department of Overseas Trade (usually abbreviated to D.O.T.) is certainly doing its utmost in the way of propaganda to let the great trading concerns of this country have a full knowledge of the assistance which the Government is now prepared to give to commerce generally. With this end in view they have just issued a hand-book which gives in brief form an account of the activities of the department and will appeal to every enterprising commercial man. Copies may be obtained free by United Kingdom merchants and manufacturers on application to the Dept. of Overseas Trade at 35, Old Queen Street, Westminster, London, S.W. 1.

Woodwork for Wireless, etc.—Mr. J. Lathwood, of 3, Maidstone Road, N.11, is a specialist in engineers' patterns, wireless cases and general woodwork, and as such will be pleased to receive inquiries. See his advertisement on prepaid page.

Finance.—The report of the South London E.S. Corp., Ltd., for the year 1922 shows an available profit of £40,000, and the directors recommend payment of a dividend on the ordinary shares equivalent to 10 per cent. per annum, carrying forward £9,600.

Obituary.—We regret to announce the sudden death, on Wednesday, the 14th inst., of Mr. Geo. Roberts, who for 25 years had been on the staff of the D.P. Battery Co., Ltd., Bakewell. During most of this time he held the position of works superintendent.

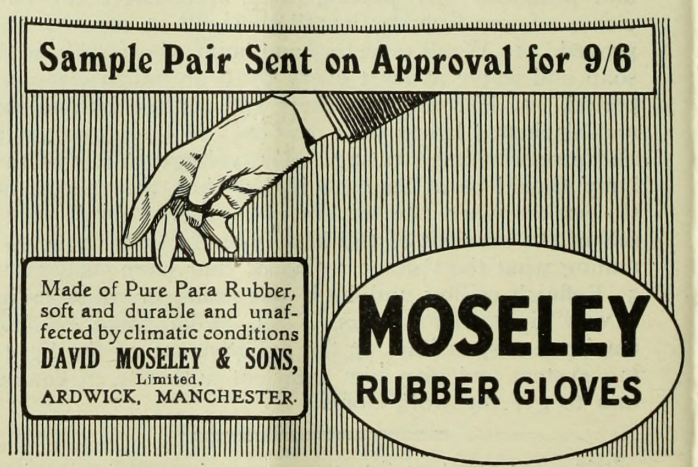
Tender Accepted.—The Spearing Boiler Co., Ltd., have secured the order for extension of boiler plant for Newport (Mon.) Corporation Electricity Works. We understand this company has also recently secured contracts for several important industrial undertakings, including boilers using waste-heat gases.

Agents Wanted.—The Liverpool Marine and General Insurance Co., Ltd., of 7, Angel Court, London, E.C.2, are anxious to obtain as many agents as possible in the wireless and electrical trades, and invite applications from our readers, who will remember that we have referred to this company on several occasions as the pioneers in the wireless apparatus insurance field.

A Good Dictionary.—The Funk and Wagnalls Co., of Salisbury Square, E.C.4, have just put on the market a good new abridged dictionary which is very up-to-date in regard to electrical and radio terms, so that it is certain to appeal to an enormous circle of readers. Anyone who is interested should fill in the coupon on page vii. of last week's issue, or send them a card mentioning this notice.

Good for Europe.—We notice in the March 1 issue of the *Telegraph and Telephone Age* that at the present time 30,000 miles of submarine cable are being manufactured for American communication companies, and, what is more, not a foot of this deep-sea cable is to be made in the United States. The leading cable-makers of the world are in England and Germany, and the American wire- and cable-making concerns are not credited with having facilities for turning out this highly specialised product.

"**Flash-o'-Lite.**"—To convert an ordinary into a flashing lamp for window display and advertising purposes, the "Flash-o'-Lite" lampholder adapter has been placed on the market by the General Electric Co., Ltd. The device is small and has a distinctive feature in the adjusting screw whereby the period of the flash can be regulated. The thermal strip is carefully wound with high-grade wire, and the platinum-silver contacts are substantially designed so that with the clear and decisive break obtained the flasher will stand any amount of hard work. When set normal, the light is "on" for three seconds and "off" for two seconds.



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A POPULAR SCIENTIFIC WEEKLY JOURNAL
ELECTRICITY
A PRACTICAL TRADE JOURNAL

MARCH 30, 1923.

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MORE "SUN" IN CHARING CROSS ROAD.

It is always a pleasure to comment on the growth of any large industrial undertaking, more particularly when it is directly connected with our own industry, and it was therefore very gratifying to have an invitation recently to visit the greatly enlarged offices, showrooms and warehouse of the Sun Electrical Co., Ltd., at 118-120, Charing Cross Road, London. Mr. Beaver's energetic but skilful management during the last twenty years, supported by Mr. Morton's ability on the publicity side and the enterprise of many first-class representatives at their branch offices and on the road, increased the company's turnover to such an extent that the premises hitherto occupied became entirely inadequate, and much of the very large floating stock had to be kept constantly on the move or was stored in neighbouring premises which did not lend themselves to efficient organisation. By purchase and lease the company has now been fortunate enough to secure roomy buildings extending from the front in Charing Cross Road to the rear facing St. Giles' Church, with two convenient means of access and exit for cartage. Fig. 1 shows the ground floor plan as at present

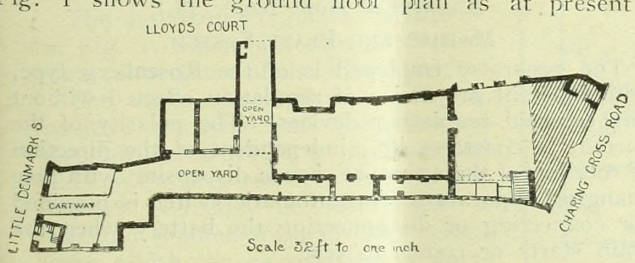


FIG. 1.—PLAN OF PREMISES.

arranged, the shaded portion being the old premises and the white the extension. This will give a good idea of the space which has been added.

With regard to the new internal arrangements, these have been carried out very thoroughly and systematically. The old ground floor front is a spacious and well planned sales department, with numerous wall showcases and central sales counters, with storage bins for standard goods required for urgent orders. Below the ground floor is a roomy basement used for storage and other business purposes as well as a comfortable room for the use of the travellers.

The first floor is devoted to the main showroom, which is of ample dimensions, and from its ceiling and walls hang fittings, brackets, etc., of almost every conceivable style, all of which can be shown in actual

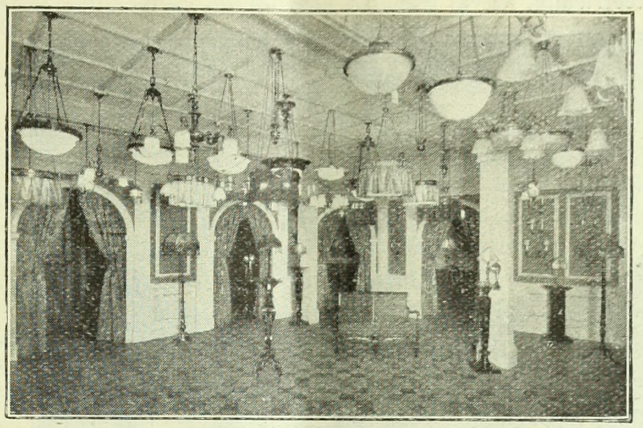


FIG. 2.—ENTRANCES TO THE "PERIOD" ROOMS.

use. One special corner is arranged for a demonstration of reflector lighting for shop windows, and immediately adjoining there is a series of "period" rooms adapted for the display of the special fittings suited to the actual style: Jacobean, Georgian, Adams, etc. It is therefore essentially the sort of place to which a contractor can take or send a likely client who wishes his installation carried out in a way to harmonise with the surroundings. Other rooms on the same floor

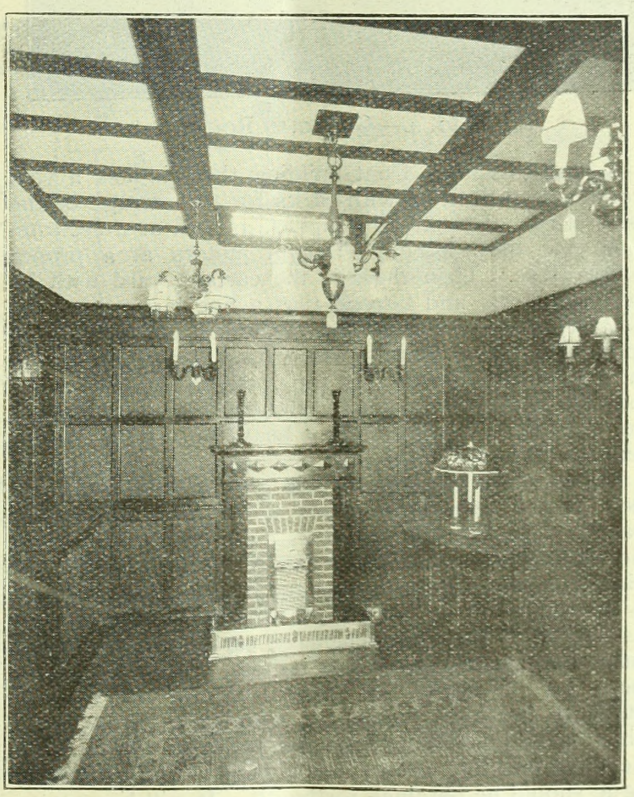


FIG. 3.—JACOBEAN ROOM.

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are arranged for the display of wireless supplies, electric cookers and domestic labour-saving apparatus generally, all of which pass through special tests before despatch.

Above the showroom we come to the second floor, which is devoted to commodious and well-lighted offices, and the third floor is partially devoted to a rest room and a staff canteen in which all cooking is done electrically.

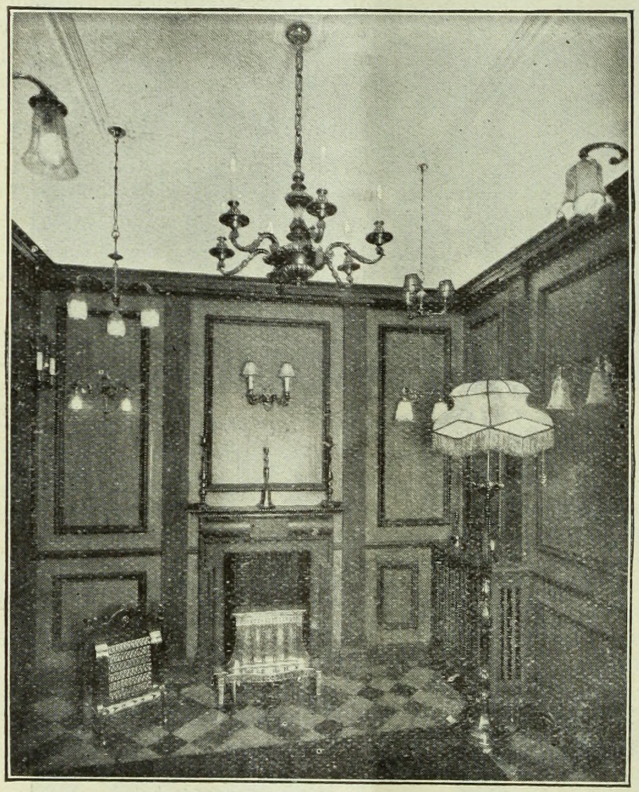


FIG. 4.—GEORGIAN ROOM.

Behind this main front building there is now a vast warehouse well fitted with racks for the storage of the general run of electrical supplies, as well as a separate room for the storage of small motors at a proper temperature. Then there is the cartage yard with its two entrances, and beyond that a fine large store for conduit, and workshops for the repair of motors and apparatus, motor testing, etc. As a matter of fact all these extensions mean that the company has now more than four times its former accommodation, and although the outlay involved has been a heavy one, we are confident that it will be more than justified in the near future.

The annexed illustrations will give our readers some idea of the showrooms and enable installation contractors and electrical engineers generally to appreciate the efforts which are being made by the company to widen its sphere of usefulness and help its trade clientele to the utmost of its power. In this connection we can also refer to the comprehensive catalogue of electric fittings which they have just issued. In its 224 pages there are hundreds of illustrations of electroliers, pendants, brackets, flambeaux, standards, shades, etc., which should enable a contractor to please the fancy of the most exacting client, and a copy of the said catalogue should be obtained forthwith. It will be sent on receipt of trade card.

PAPER: RECENT DEVELOPMENTS IN ITS MANUFACTURE.

The selection of paper for a technical journal is naturally a matter of interest both to the reader and the editor—of somewhat painful interest to the latter during recent years. The address with the above title, read by Mr. J. L. Greaves before the Circle of Scientific, Technical and Trade Journalists on February 27, was therefore one of general interest. By the aid of lantern slides the lecturer took the audience through all the stages of paper manufacture, and also illustrated his remarks by exhibits of materials at various stages of production and specimens of rare and special papers.

The chairman (Sir Richard Gregory) pointed out that great advances in methods of manufacture have been made by British manufacturers during recent years, and remarked on the gratifying fact that the necessary material is drawn from within the British Empire.

To electrical engineers paper mills are of considerable interest, in view of the very difficult problems that arise in driving the machinery. Dr. J. F. Crowley, in fact, pointed out that these severe requirements have had a most important influence on the design of motors during recent years. Another point of view—that of the illuminating engineer—was referred to by Mr. Gaster, who suggested the desirability of avoiding very highly glazed papers where possible, in view of the troublesome direct reflection of light that arises. He recalled that some years ago a special instrument for measuring and specifying the gloss on paper was devised by Mr. A. P. Trotter, in connection with the British Association Committee on School Books and Eyesight.

RECTIFYING CRYSTALS FOR WIRELESS APPARATUS.

Several inquiries have recently been received at the D.O.T. for the names of wholesale suppliers of rectifying crystals for wireless apparatus. Firms who are in a position to supply such crystals may obtain the names of the inquirers on application to the Department at 35, Old Queen Street, London, S.W.1. (Reference 7893/T.E./E.P.)

SOME TRAIN LIGHTING SYSTEMS.*

BY CYRIL T. COCKS.

(*Continued from page* 148.)

MATHER AND PLATT SYSTEM.

The generator employed is of the Rosenberg type, with inherent properties of regulation effected without any external regulating devices. The polarity of the current is constant, i.e., independent of the direction of rotation of the armature, hence dispensing with pole changing apparatus. An automatic switch is provided for connecting or disconnecting the battery when the train starts or comes to rest.

Two batteries are employed. A resistance in series with one of them is for the purpose of allowing that battery to be used merely as a regulator. The other one, absorbing the greater portion of the charging current, consequently takes over most of the load when the train is standing. An automatic switch is provided for the purpose of interchanging the functions of the two batteries every time the lamps are switched on.

* Abstracted from the *Transactions of the South African Institute of Electrical Engineers.*

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PINTSCH SYSTEM.

In this system one-half of the battery is used for field regulation and lighting during stoppages, whilst the other half is being recharged. The voltage regulation of the generator is based on an extremely simple principle. The field resistance is so low that a p.d. of ½ volt will cause a current of four amperes to flow, sufficient to excite the machine fully at the lowest working speed.

The regulating battery is in series with the shunt field, hence when the voltage between the brushes equals the e.m.f. of the cells no current is flowing through the field winding, and the generator voltage becomes zero. A current then flows from the battery, but as the field winding requires only ½ volt to become fully excited, the currents are once more equalised. It is obvious, therefore, that the generator voltage can never differ from that of the regulating battery by more than a ½ volt.

For the purpose of charging, the armature has two independent windings, with independent commutators. One winding gives the correct pressure for the lighting, the other, with its commutator in series with the former, supplies the additional pressure necessary for charging.

Note.—These five systems, together with the two systems which form the basis of the paper, embody practically all the principles of regulation which are employed in train lighting generators.

VICKERS SINGLE BATTERY SYSTEM.

The Vickers Single Battery System comprises a dynamo, dynamo regulator, and a battery of 12 cells.

The dynamo is a shunt wound machine of the variable speed type with a movable brush carrier, which relies on the friction of the brushes on the commutator to rock the brushes over against the stops in the direction in which the armature is revolving, thus maintaining the terminal polarity, no matter in what direction the train is travelling.

The dynamo is slung under the carriage underframe, and is driven from one of the axles by a belt, the tension of the latter being maintained partly by the weight of the dynamo and partly by springs.

The automatic regulator is shown in Fig. 1, which also shows the complete connections of the whole system.

The main current flows from the positive terminal of the dynamo through the main fuse to the lamp and battery circuits respectively. In the battery circuits is interposed a solenoid shunted by a diverter resistance, which can be adjusted by varying the position of the contact B.

Another smaller lead from dynamo positive terminal, passing through a fuse, connects three circuits, one to the shunt winding of the automatic switch, which connects the dynamo on to the cells when the dynamo has reached predetermined voltage, which must approximate as near as possible to that of the cells; one on a small automatic switch, the battery stop-change switch; and the third on the main regulating solenoid, controlled by the stop-change switch.

The regulator solenoid, which is normally excited by the current passing through the dynamo to the battery, acts upon a core connected to the field regulator, which varies the resistance in series with the dynamo field coil. The steps of the resistance are connected to thin metallic strips sandwiched between layers of insulating material, their upper edges forming a track upon which the regulator contact rolls, as shown in the accompanying drawing. The contact maker consists of a bundle of copper laminations, V-shaped in cross section, with their edges applied to the track, and is tilted to and fro by the core of the solenoid, the roller being connected to the small positive branch from the positive terminal previously mentioned. An air-dash-pot is used to reduce sudden movements that would otherwise occur.

Should the battery be charged for so long a period that its voltage rises beyond a predetermined limit, the small automatic switch is actuated and closes the circuit through the fine wire winding on the solenoid, which assists the main winding, and therefore inserts a larger resistance in the dynamo field circuit; this has the effect of reducing the charging current to a few amperes.

A separate regulator is provided for controlling the voltage of the lighting circuits, based on the same principles as the regulator-controller, but with the

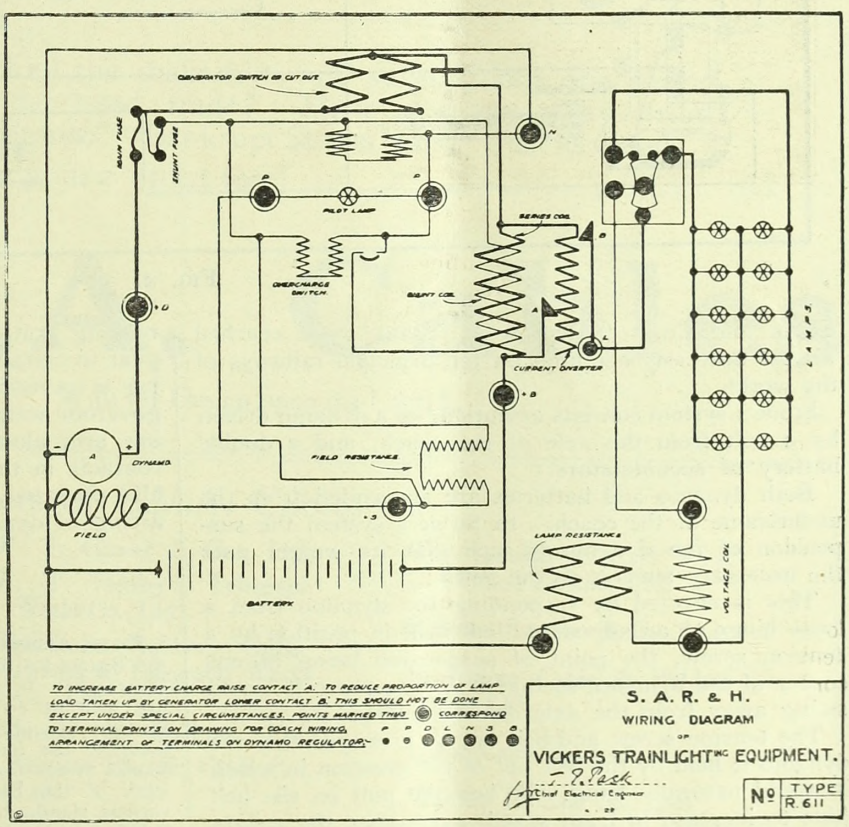


FIG. 1.

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difference that in this case the actuating solenoid is wound with fine wire and acts so as to maintain the voltage constant by short-circuiting more or less of the resistance, which carries the current going to the lamps.

Stone's Double Battery System.

Stone's Double Battery System may be taken as the standard adopted by the S.A. Rly. Administration. As has been previously stated, this system was first introduced to the railway world in the year 1894, and was first introduced into South Africa and successfully installed by the N.G.R. in 1897.

Fig. 2 shows the general arrangement of this system which was first invented by Mr. A. B. Gill, and was afterwards developed and improved by Messrs. J. Stone and Co., of Deptford. It has since reached almost universal adoption on the principal railways of the world.

Stone's system consists essentially of a dynamo driven by a belt from the axle of the coach, and a double battery of accumulators.

Both dynamo and batteries are suspended from the underframe of the coach. In Stone's system the suspension of the dynamo is such that its weight puts the necessary tension on the belt.

This is effected by suspending the dynamo from a loose hinge to an adjustable link held in position by a tension screw, the point of suspension being at one corner of the dynamo, so that if free to move it would swing away from the axle driving pulley.

The tension screw and belt are so arranged that the dynamo is held by the belt out of the position in which it would naturally hang. [When the pull on the belt (due to increase in train speed) overcomes the weight on the belt (due to suspension of the dynamo) the latter will be automatically drawn towards the driving pulley, thus allowing the belt to slip, while the armature will continue to revolve at normal speed and constant torque.]

In the earlier type of Stone's dynamo, known as the Gill machine, the "cut in" and "cut out" is controlled mechanically in the following way: A small switchboard is mounted at the commutator end of the machine, which carries the "cut in" and "cut out" switch.

A centrifugal governor with adjustable weights is fixed on the end of the armature spindle, and to the movable sleeve of this is secured the rocking arm, to which the main movable contacts are attached, as will be seen in diagram. When the armature revolves the rocking arm is carried round by means of the friction gear to certain limiting stops, at the same time operating a reversing switch; as the speed increases the governor weights fly out, moving the sleeve with rocking arm along the shaft, axially, closing the comb contacts in their correct order. This axial movement also operates a carbon brake, thereby eliminating any arcing of dynamo contacts.

(To be continued.)

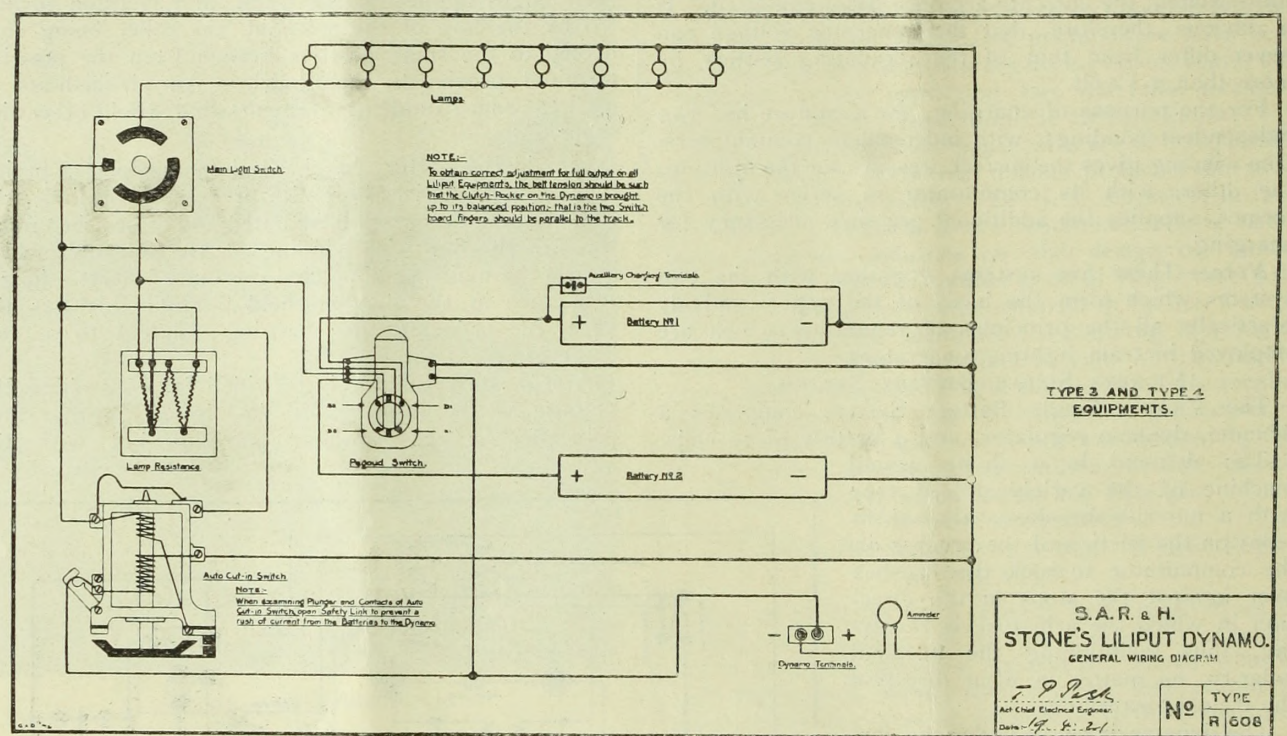
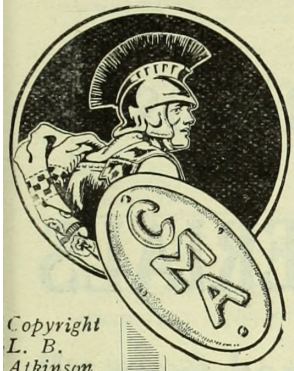


Fig. 2.

Beama Annual Report.—The annual report of the Council of the Beama for the year 1922 has just recently been issued. It shows that, in spite of the trade depression, the Association has held its own, and that, generally speaking, we can look forward to a steady improvement in trade. Reference is also made to the forthcoming British Empire Exhibition, to the World Power Conference, due to be held in 1924, and to the work of the Electrical Research Association, as well as to various standardisation rules which have been issued by the B.E.S.A. Altogether, the report contains matter which will prove of direct interest to a very wide circle of readers.

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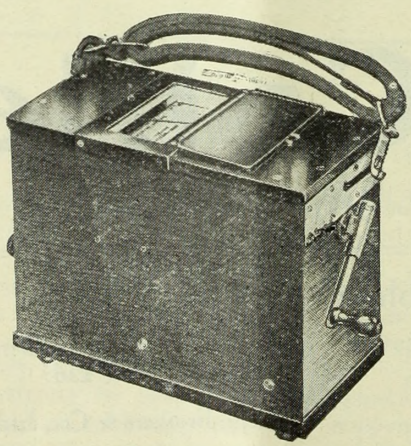
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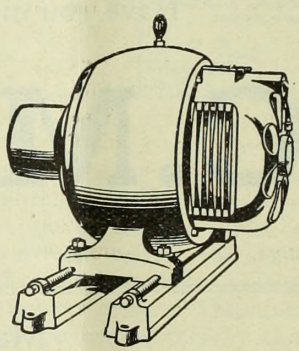


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TO OUR READERS.

ELECTRICITY is published every Friday, and, if ordered, is on sale at the principal Railway Station Bookstalls and Newsagents on that day. It has a very large sale throughout the United Kingdom, as well as in the British Colonies and Abroad.

New advertisements for the displayed columns and alterations to existing ones must reach the publishing office not later than first post Tuesday morning, in order to be in time for the issue of the following Friday. This is important. Rate quoted on application. Subscription: 13s. a year, 6s. 6d. half year, 3s. 3d. a quarter in advance, postage prepaid in the United Kingdom and abroad.

Questions to which an answer is required must be accompanied by a 1½d. stamp for reply. When considered of sufficient interest, the answer will probably appear in the paper.

All remittances payable to the Publishers, S. RENTELL AND CO., LTD., 36-39, Maiden Lane, London, W.C.2. Telephone No. 2460 Gerrard.

Current Topics.

Where Your Money Goes.

A recent appeal case in the House of Lords throws interesting light on the lavish manner in which the taxpayers' money was dissipated during the war, and, apparently, in view of the decision in the case above referred to, is to be dissipated still further. The case was one brought by a representative of the Union of Post Office Workers against the Crown, and sought a decision on the payment of war bonus on their *civil* pay to those Post Office servants who served with H.M. Forces as telegraphists, signallers, etc. It seems that, in September, 1915, the Postmaster-General issued a circular setting forth that Post Office servants enlisting as office telegraphists in the Royal Engineers would be allowed *full civil pay in addition to military pay* when called up for service, and the appeal turned on the interpretation of the term "full civil pay."

During the period following the enlistment of certain Post Office employees under the terms of this circular certain war bonuses were granted to various grades in the Civil Service, among others, to the Post Office employees affected by the above circular. The Union of Post Office Workers sought to establish the principle that "full civil pay" included such bonuses as might be awarded to them in their civil capacity, subsequent to enlistment in the Royal Engineers, and, on the purely legal aspects of the case as decided by the Lords of Appeal, they have won their case, as a result of which John Citizen will once more have to pay for the sins of commission of the Government of that period. As to the justice of the case there can be no two opinions. At a time when everyone made sacrifices and service was compulsory, the more prosperous employers established and, to their honour be it said, maintained the principle as far as possible of making up the difference between the normal salaries of their employees and their military pay.

On the other hand, many thousands of employees had perforce to sacrifice their jobs and join up without hope of recompense other than their purely military pay. The Post Office, on the other hand, being custodian of a portion at all events of the nation's purse, felt justified not only in making up the difference between civil and military pay, but maintaining full civil pay, notwithstanding the fact that their absent employees were being paid the normal allotments as units in the Royal Engineers. Thus these lucky Post Office men, serving with the Forces, were drawing two independent salaries for the duration of the war. Not content with this very inequitable and anomalous arrangement, they now succeed, on appeal, in annexing a considerable additional sum by way of bonus on their civil pay which they were not there to earn. No one questions the fact that these men did their bit, and no doubt an invaluable bit, in helping to win the war, but, when all is said and done, they have been more than repaid already for their services, and, by comparison with thousands of conscripts with no right of appeal, they have already been overgenerously rewarded. However, the taxpayer gets his hand down once more, as usual.

First-Class Trams.

Report has it that the first-class tramcars, which have been a feature of the Liverpool tramway service for some years, are to be taken off, as they do not pay. On many of the routes the lower deck of the cars is marked "First Class," which meant that for double fare passengers could sit on blue plush cushions, enjoy a somewhat better interior decoration, and, since strap-hanging was not allowed, ensure occupancy of the seat for which they had paid. After all, these cars have served a very useful purpose, and there is likely to be keen controversy when the proposal to abolish them comes up before the City Council. The main trouble in Liverpool is insufficient rolling stock and hopeless overcrowding. Encouragement of overcrowding and strap-hanging by the Corporation tramway authorities puts a premium on any form of relief from this very uncomfortable and insanitary transport condition. Many hundreds of Liverpudlians are always prepared to pay the extra fare demanded on the first-class cars, simply because the ordinary or third-class service is so inordinately bad.

Another factor which may have contributed to the financial failure of the superior service of cars is that the first-class cars are seldom in evidence on the particular route and at the particular time that one requires to travel and would willingly pay extra for the privilege. Although, nominally, a time table is in existence to which the cars are supposed to conform, once they leave the various termini there would appear to be very little attempt made to adhere to the stated times of arrival at or departure from intermediate stages, and if one wishes to get from point to point it is a case of taking the first car that offers, whether first or ordinary. As a frequent visitor to Liverpool I shall miss the "firsts" if they have to go; they afforded one an occasional sporting chance of travelling seated, a fact which was well worth the extra copper or two charged for the accommodation. Incidentally, why do not Liverpool ratepayers insist on better service from their tramways department? They certainly don't get value for money to-day.

Why Fireplaces?

Now that everyone is urging builders to build, and we are preaching the gospel of the All-Electric House, why, in the name of conscience, provide every living and bedroom with the old-fashioned fireplace and its accompanying flues? Fireplaces not only add to the cost of building in the shape of additional brickwork, mantelpieces, hearths, surrounds, etc., but they also reduce the effective cubic space of the room, and conduce to draughts, therefore, wherever electrical energy

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is available at a reasonable rate for heating and cooking the fireplace is surely redundant. Admittedly flues are a *sine qua non* where gas heating and cooking are concerned, but electricity creates no noxious fumes, smoke or vapour to necessitate a means of egress to the outer air. Moreover, manufacturers and vendors of electric radiators and cooking ranges are prone to exhibit and illustrate as well as actually fit these appliances in a fireplace, in spite of the fact that one of the manifold advantages of electric heating is its adaptability and portability within the confines of the room in which it is used.

The cost of houses is constantly being cited as one of the difficulties in the way of better housing, yet architects and builders do not appear to have grasped this golden opportunity to eliminate a considerable percentage of that cost by designing and building houses without fireplaces. I know that, as a race, we are wedded to the idea of the fireplace, but that is simply because we have been bred and born to a custom or convention, if you like to term it so. Your critic will probably say: "But where am I going to pull up my chair and settle for the evening if I have no fireplace?" The obvious reply is: "Make your own fireplace wherever the fancy takes you, and in the most comfortable corner of the room. Fit a cosy corner settee, and place your electric radiator in a favourable position so that all seated in the vicinity derive full benefit from its glowing rays. Move it about to suit your convenience. It is pre-eminently adaptable."

In this connection I am indeed glad to note that architects and electrical engineers are at last putting their heads together. In the demand for ideal homes the two professions have many interests in common. Hollow bricks and moulded blocks make for convenient and low cost wiring schemes; scientific illumination is of interest to the architect, as are also the provision of electric cookers, electric hot-water systems, electrically driven vacuum cleaning plants, and numerous other domestic applications of electricity. Finally, there is this vital question of derelict fireplaces and the consequent economy and acceptable modifications in design which their absence would enable architects to incorporate. Last, but not least, there is the permanent and clinching effect upon the tenant of a house without fireplaces. He is wedded to electricity for the full term of his tenancy, a factor which should go far towards assisting general electrical development.

The Beama Report.

Last week I commented on the annual Beama dinner, and now I have before me both the official annual report and the report of the proceedings at the annual meeting itself. The official report is, I am informed, referred to in another part of this issue, so I shall confine myself to the meeting. Mr. Longbottom presided, and, after the report and balance-sheet had been adopted, he went on to explain the various directions in which the association's energies and interests were being pushed. For instance, it is good to hear that approximately 80 per cent. of the space at Wembley allotted to the electrical and allied engineering sections has already been applied for. A strong committee is being formed to organise the engineering section of the World Power Conference, while thanks were courteously expressed for the work of the Traffic Committee during the past twelve months.

Members are again asked to support the *Beama Journal*, and in the official report it is frankly admitted that it does not pay. I am not in the least surprised, and I still fail to see its value. The advertisers therein can certainly admire each other's advertisements, but in my (decidedly biased) opinion the money could be spent to much better advantage in the legitimate trade journals associated with the electrical and engineering industries. They go all over the world and cover the ground far better than the *Beama Journal* is ever likely to succeed in doing, more particularly in view of the chairman's own words to the effect that "it is not our object to advertise the association."

However, that is my grumble, and it is, of course, a prejudiced one. The fact remains that the *Beama*, under its present skilful control, is doing quite a lot for the whole of our trade in a quiet and unobtrusive, but none the less effectual, manner, and I do most sincerely hope that it will receive the strong support which it so amply merits.

Elektron.

Questions and Answers by Practical Men.

RULES.

Questions: *We invite our readers to send us questions, preferably on technical problems that have arisen in actual practice. Questions which we consider of sufficient interest to our readers will either be replied to under "Answers to Correspondents" or replies will be invited from our readers. One shilling will be paid for the question which we select for competitive replies in this column.*

Answers: *A fee of 10s. will be paid for the answer which we consider shows the greatest merit, and 5s. for the one we select as second best. In judging the replies, importance will be attached to clearness and conciseness, as well as accuracy. The Editor reserves the right to make no award, or to accept only one reply, if, in his opinion, the answers received do not possess sufficient merit. Competitors desiring the return of their manuscripts, if unaccepted, should enclose stamped addressed envelope.*

Write on one side of the paper only, and if diagrams are sent, draw them on a separate sheet of paper attached to the manuscript. Competitors may adopt a "nom de plume," but, both in the case of questions and answers, the competitor's real name and address must be sent with the manuscript as a guarantee of good faith. No correspondence will be entered into with regard to successful replies. The Editor's decision is final.

Commencing with Question No. 101, a Diploma of Merit will be awarded to the six competitors who win the first or second prize the most times during the next twelve months.

The words "Questions and Answers" or "Q" and "A" should be placed at the top left-hand corner of all letters intended for this column.

Question No. 157.

Can any reader give me details from which I can make a Nodon Valve to enable me to charge accumulators from an A.C. supply? What is the action of such a valve?—"Wireless."

Question No. 158.

I have to repair a number of accumulators. My difficulty is that I do not know how to connect the bridge pieces, that is, the bars which are connected across the top of each set of plates. I understand that these are "burnt" on. How is this done?—"Accumulator."

(*Replies to Questions* 157 *and* 158 *must be received not later than April* 28, 1923.)

Meetings.—The Junior Inst. of Engineers will hold their annual dance on Friday, April 6, at the Cannon Street Hotel. Reception, 6.30; dancing commences at 7 o'clock. On Friday, April 13, there will be a meeting at 39, Victoria Street, at 7.30 p.m. Paper: "Instrument Equipment of Aeroplanes," by C. B. Clapham, B.Sc. (Member). Slides and exhibits.

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VACUUM TUBES SUCCESSFULLY USED IN TRANSATLANTIC TELEGRAPHY.*

According to announcement made by officials of the Radio Corp. of America, another scientific accomplishment looking toward transoceanic telephony and the use of vacuum tubes for transoceanic telegraphy was made when an experimental, high-powered tube set at Radio Central, Rocky Point, L.I., was operated continuously 16 hours, handling commercial transatlantic traffic with Great Britain and Germany, on a wave length of 19,000 metres.

The statement reads that plans for the development of the new electron tube experimental set were completed in December, 1921, by representatives of the research and engineering departments of the General Electric Co. and the Radio Corporation, and the manufacturing of this highly delicate and specialised set was immediately started in Schenectady, N.Y. So fast did the work progress that in May last year the temporary installation of the set was started at Radio Central, and when Senator Marconi visited the station in July, preliminary tests were in progress under the direction of W. R. G. Baker, of the General Electric Co., and C. W. Hansell, of the Radio Corporation.

The set is, for the time being, composed of three 50-kilowatt, 15,000-volt, water-cooled, metal vacuum tubes, known in the engineering world as kenetrons, used as rectifiers, and six 15,000-volt, 20-kilowatt, water-cooled, metal pliatrons, used as high-frequency converters. For the experiment with the tube set, one of the new mile and a half long antennæ suspended from six towers, 426 ft. high, of the Rocky Point station was used, and the tube set succeeded in developing and sustaining in the antennæ a current strength of 350 amperes.

So successful was the set in operation that the operators actually controlling the automatic sending keys at 64, Broad Street, in New York City, did not know that they were controlling a tube transmitter rather than an alternator until after the test was completed.

It was said that while the set in its present stage was far from being a reliable commercial transmitter, the tests just concluded show that an alternative type of equipment to the Alexanderson alternator is on the way to aid America in building up its world-wide wireless communication system.

It also further substantiates Marconi's prediction that once reliable international telegraphy is established by using tubes, telephony must follow in its wake as a matter of course.

When Dr. E. F. W. Alexanderson, chief engineer of the Radio Corp. of America and inventor of the Alexanderson alternator, was informed of the success of the experiment, he made these comments:—

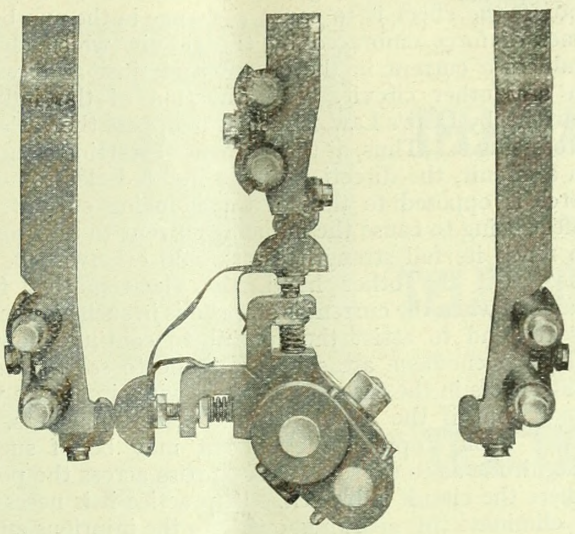
"Transatlantic telegraphy has become a routine business, but the importance of this demonstration is the bridging of the ocean by a few powerful vacuum units. In this case only six tubes were used, and we can safely predict that the same feat will some day be performed by a single tube. But what is next? We have here seen a new physical principle reduced to practice on a large scale. Shall it fulfil the dreams that Edison's dynamo has not yet fulfilled, to carry Niagara's power to New York?

"It marks a turning point like the steam engine and the dynamo. It will certainly give us transatlantic telephony, but it will undoubtedly give us much more."

* *Telegraph and Telephone Age*, N.Y.

M.-V. AUTO-TRANSFORMER AND STAR DELTA STARTERS.

The question of the choice of suitable starters for two- and three-phase squirrel-cage motors is dealt with by the Metropolitan-Vickers Electrical Co., Ltd. (Trafford Park, Manchester), in their descriptive leaflet No. 59/5-1. These starters are of the drum type, with oil break and contained in substantial cast-iron frames having cast-iron covers and supporting a welded iron oil tank, so designed as to be weatherproof and dust-tight. Complete access to the switch is obtained by



removing the oil tank, and to the automatic release mechanisms by removing the cover. Among the features is the following:—

The moving contacts for each phase are joined by heavy flexible laminations, so that sliding supports and springs are not relied upon to carry any current. Easily and cheaply renewable sparking pieces constitute the fixed contacts, which are attached to vertical supporting rods. These rods project upwards through the oil, and are fitted with insulating sleeves to remove all possibility of a flash-over should dirt be allowed to settle on the surface of the oil.

The illustration shows the method of fixing the contacts on the insulated supporting rods, the compression springs and the flexible laminations, and the renewable arcing tips.

Copper Wire.—An advertiser wants to buy some bare hard-drawn copper wire, second-hand. For details, see small advertisement.

Finance.—The report of the Clyde Valley E.P. Co., Ltd., for the year 1922 shows an available profit of over £200,000, and, after paying dividends on the preference shares and making allowance for the contingency fund and special reserve, there remains an available profit balance of over £85,000, which will permit of a dividend equal to 8 per cent. per annum on the ordinary shares, and carrying forward nearly £34,000.

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TELEGRAPHY.*

Being Solutions to the Questions set by the City and Guilds of London Institute at the Final Grade Examination in Telegraphy held in May, 1922.

Compiled by a Silver Medallist.

(*Continued from page* 154)

Q. 5.—What is self-induction or inductance, on what does it depend, and what are its effects? Define precisely the unit of inductance. Is the inductance of a standard relay a constant quantity? What are the relative values of the inductance of a standard relay with the coils in series and in parallel respectively? If L is the inductance and C the current flowing, what is the value of the energy stored in the magnetic field? What happens to this energy when the current ceases? What would be the effect of winding the coils with platinoid wire instead of copper wire?

A.—When the strength of the current in a circuit varies, the effect is to cause a change in the number of lines of force embraced by the circuit, which change induces a current in the circuit itself just as it would in any other circuit. The direction of the induced current, by Lenz's Law, is such as to oppose the variation producing it. Thus, at the moment of starting a current in a circuit, the direction of the induced electromotive force is opposed to that of the inducing current, the effect being to cause the inducing current to take longer to reach its full strength than would otherwise be the case. On the other hand, the electromotive force induced when the current is stopped is in such a direction as to tend to assist the current to continue flowing. These phenomena are said to be due to *self-induction*. The effects in the case of a straight wire circuit are very small, but if the circuit contains electromagnets, the effect upon stopping the current may be of such a magnitude as to cause a spark to pass across the points where the circuit is broken. In practice it is necessary to eliminate this sparking, owing to the injurious effects it has upon the contact points at the break; this may be effected either by connecting a condenser in series with a resistance across the points where the break occurs, or by shunting the electromagnet with a non-inductive resistance.

The number of lines of force embraced by a circuit when a unit current flows in it, is termed the *coefficient of self-induction* of the circuit. It depends solely upon the geometrical configuration of the circuit and upon the permeability of the surrounding medium.

A circuit possesses a coefficient of self-induction of one C.G.S. unit when a current of one C.G.S. unit flowing through the circuit causes one line of force to be embraced. The practical unit is the *henry*, equal to 10^9 absolute C.G.S. units.

Assuming that in the case of a given circuit the permeability of the surrounding medium is constant, then the flux F for a current I will be given by

$$F = LI$$

Where L is the *coefficient of self-induction* (or inductance) of the circuit. The flux therefore varies with the current in the circuit. The induced electromotive force is equal to the rate of change of flux due to the change in the current. Calling it e, we have by differentiating with respect to time

$$e = \frac{dF}{dt} = \frac{LdI}{dt} \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Equation (1) may be written

$$L = \frac{\text{Induced e.m.f.}}{\text{Rate of change of current}}$$

If the induced e.m.f. is unity for unit rate of change of current, then L will be also unity, hence the following definition:—

A circuit possesses *unit inductance* when an e.m.f. of one C.G.S. unit is induced when the current changes at the rate of one C.G.S. unit per second.

If I is in amperes, and e in volts, then L will be in henrys; the henry may therefore be defined as:—

The *inductance* of a circuit such that an e.m.f. of 1 volt is induced when the current changes at the rate of 1 ampere per second.

The inductance of a standard relay is not a constant quantity but depends upon the strength of the current passed through the relay in making the measurement, and also on the proximity of the armatures to the pole pieces.

The inductance of a standard relay with its coils in series is approximately four times that when the coils are connected in parallel.

If L is the inductance of a circuit and C the current flowing, then the energy stored in the magnetic field is equal to $\frac{1}{2}LC^2$; when the current ceases an equivalent amount of heat is produced in the circuit.

The effect of winding the coils of relay with platinoid wire instead of copper wire would be to increase considerably the resistance of the instrument.

(*To be continued.*)

* Consult also "Questions and Solutions in Telegraphy and Telephony," Final Grade, by Few, 2s. 3d. post free from Electricity Office.

ELECTRICITY IN COTTON MILLS.

During the recent local inquiry before the Electricity Commissioners at Preston, Mr. W. Birtwistle (the largest cotton manufacturer in Lancashire) said his mills were driven partly by electricity and partly by steam. If his applications to Blackburn Corporation were acceded, his Blackburn mills would nearly all be driven by electricity. His experience of electricity for mills showed it had many advantages over steam. The highest rate of speed attained by engines in most mills was very important in spinning. With steam the speed varied, with electricity the highest speed could be maintained. Electrical energy was cleaner, and ensured a bigger output. He looked forward to the time when all his mills would be electrically driven. He had found, where his mills were electrically driven, they were getting the same results for a 48-hour week as for the previous 55½-hour week. Where there was steam power this had not been the case. With electricity they could economically shut down portions of a mill in bad times.

Cost Accountancy.—The April issue of *The Cost Accountant*, which will be published on April 5, will contain a verbatim report of the proceedings of the second annual Costing Conference, on the subject of "Standardisation in Cost Accountancy." Copies can be obtained from the Inst. of Cost and Works Accountants, 38, Grosvenor Gardens, S.W.1, price 1s. 7d. per copy, post free. Subscription, 18s. per annum.

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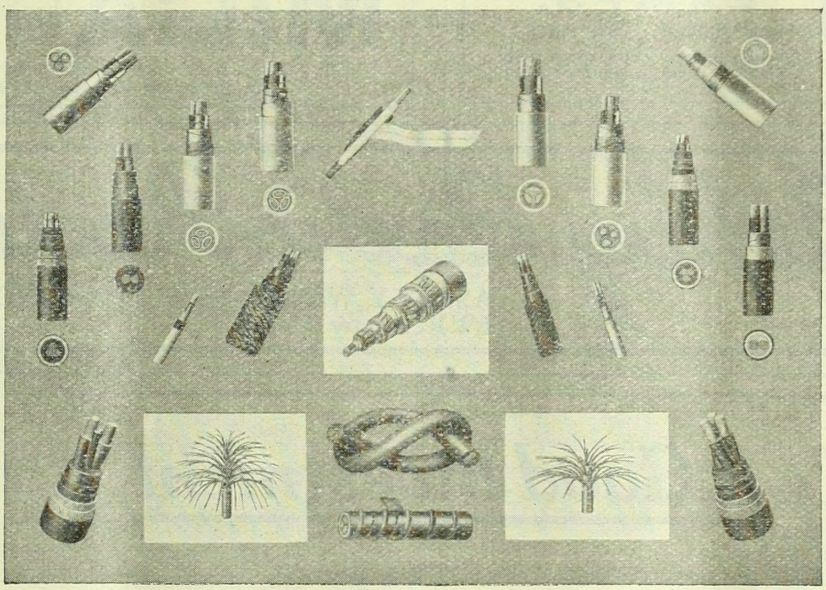
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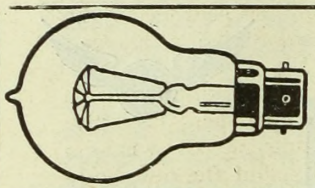
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DEVELOPMENT OF PUBLIC ELECTRICAL SUPPLY IN GREAT BRITAIN.

By C. H. WORDINGHAM, C.B.E., A.K.C., ETC.

(*Continued from page 147.*)

The Electricity (Supply) Act, 1919, which, with the supplementary Act passed in 1922, is now dominating the electricity supply industry in this country, has for its object the improvement, extension and cheapening of the supply, and it is a little startling to find that fundamentally this legislation is, as I have already indicated, based upon precisely the same principles as the power companies. This being so, one cannot at first sight avoid a feeling of alarm lest the well-intentioned proposals should in this case also prove abortive. Were this to be the case, it would be far more serious than the comparative failure of the power companies, because in the latter case individual authorities had free option as to the course they should pursue for supplying their areas, whereas now there is legislative compulsion to develop on the lines laid down in the Acts. If, however, the reasons which I have just advanced be the true ones, then all cause for alarm disappears and we may look forward to a very substantial improvement all round being effected and a vast expansion of the business.

It may not be without interest for me briefly to outline the way in which the regime is run.

Until recently, this industry of national importance was an appanage of the Fisheries and Harbours Department of the Board of Trade. A single electrical adviser, with one assistant and no other staff, was charged with the whole technical side of the Government Department's work. Other Departments dealt with other phases of the work, and the industry dragged itself up as best it could. It is possible that, as a child of nature, it grew up healthy, and, on the whole, I think it did, but it was generally felt that the time had come when co-ordination among the several separate authorities should be attempted and that development should proceed on definite lines, well thought out by those technically equipped to plan for the future.

One result of outstanding and overwhelming importance was the appointing of the five Commissioners to whom the work is now committed. Three are first-class experts in the planning, management and operation of electricity supply undertakings, one is a civil servant of high ability, and conspicuously free from red tape traditions, who has been concerned in the drafting of the whole of the Electric Lighting Acts, and knows them section by section well nigh by heart, and the fifth is a financial expert of ripe and wide experience. All are men having a high sense of duty and devoted to their work.

These Commissioners are charged with the whole of the matters arising in connection with the electric supply industry, and without their sanction no new generating station may be erected nor old one extended. It is their sole business to see that existing means of production are co-ordinated and that only the most economical new means are provided. Curiously enough, however, the Government still cling to the idea of tacking this important national industry on to some alien Department and have transferred it from the Fisheries and Harbours to the Ministry of Transport, so that even now the Commissioners have not a direct representative in Parliament, all their communications having to go through the Minister of Transport. This may not be a matter of much moment, and, perhaps, it is valuable as being characteristic of the way in which we do things in this country.

The procedure followed in endeavouring to effect an improvement in the supply is, first of all, provisionally to delimit the area in which the supply is to be improved. Public notice of this proposed delimitation is given and schemes are invited from all parties interested setting out the lines on which they propose that the betterment should be effected. A date is fixed by which these schemes must be sent in to the Commissioners, adequate time usually being allowed for their preparation.

The scheme has to provide for the administrative side as well as the technical. The Electricity (Supply) Act, 1919, provides for the setting up of what is termed a Joint Electricity Authority, but the new body must not necessarily be on the lines therein laid down, and in point of fact procedure by way of advisory committee tends rather to be preferred. I shall have a word to say on these two forms of administration later.

After the scheme has been submitted a number of statistics, known as "Supplementary Particulars," have to be furnished. These involve an immense amount of labour in their preparation and comprise data as to the results obtained with the arrangements in force at the time, together with an estimate of the probable results of continuing to supply the area with those means, and estimates of the financial and technical results which it is anticipated will be attained if the scheme proposed be put into force. Inasmuch as these estimates involve assumptions as to the prices at which plant and mains will be obtainable ten years hence, it is obvious that the estimates may vary over a fairly wide range according to the fancy of the estimators without it being possible for anyone to be able definitely to prove that they are wrong. To a large extent, therefore, the estimates in the Supplementary Particulars are of little real value, and it is safer to judge the scheme by a consideration of the general lines on which it is framed, the Commissioners exercising the knowledge and experience which they have in judging of the probable trend of events.

After the schemes and the supplementary particulars have been submitted to the Commissioners and have been in the hands of the parties concerned for a sufficient time, a local inquiry is held within the area at which all interested parties are heard. First the promoters of the scheme or schemes, and then the various opponents, if any; often they are numerous.

The scheme or schemes having been duly torn to pieces by the contending parties, the Commissioners consider the evidence put before them, and eventually either approve one of the schemes submitted, approve it in a modified form, or issue a scheme of their own.

Particulars of the approved scheme are then communicated to the interested parties, and a second inquiry is held to hear any objections to the scheme which it is proposed to approve.

After the second inquiry a definite decision is arrived at by the Commissioners and work can be started.

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Whether or not it is started will depend upon the goodwill and financial resources of the parties concerned, there being no powers in existence to bring any compulsion to bear upon them.

(To be continued.)

THE NEED FOR CO-OPERATION BETWEEN MANUFACTURER AND RETAILER.

At the meeting of the Informal Section of the I.E.E. on the 19th ult., Mr. W. E. Warrilow was in the chair when a discussion was opened by Mr. W. S. Caine and Mr. H. T. Young on "The Need for Co-operation Between Manufacturer and Retailer."

Mr. Caine began the discussion with an outline of the systems of distribution from works to consumer, and criticised the alternative methods of mail order, branches and agents, and of the ordinary channels with factors and retailers. He did not claim that the last method was flawless, but thought that it was best for the industry to-day, and he appealed for the fullest support from the retailer upon the general principles of :—

Team work and co-operation.
Purchases on a stock basis.
Preference for British-made goods.
A reasonable profit, as otherwise sales are restricted.

Mr. Young, who followed, believed it to be the duty of the manufacturer to supply the user by the most economical method. And he thought that the contractor retailer was the correct channel to ensure this. While admitting that the industry is getting better organised, he was able to give instances of many flaws in the system of distribution.

Mr. W. R. Rawlings showed that some other industries were much more considerate of their retailers, and he suggested for the electrical trade a basis of prices with a progressive discount for a small order, for a quantity over a period, and for cash on strict terms. Manufacturers want to sell in quantities, and he felt that if the retailer were prepared to stock quantities he should get best terms.

Mr. A. Windibank believed the contractor was often to blame that the manufacturer was not considerate. His experience is that many contractors are incapable of properly handling an inquiry for plant. They often propose quite unsuitable gear and were not even familiar with the peculiar demands of their own locality.

Mr. E. C. Wansbrough suggested that all sections of the industry should give fuller support to the Electrical Development Association, and he hoped to see them unite upon a first-rate publicity campaign.

The president, Mr. F. Gill, said there must be found some way of best serving the public, and this must include a reasonable profit. He defined a reasonable profit as a return which will provide the additional capital required to carry on your business. With regard to the problem of distribution it must be possible to find a solution if the existing channels have failed, and we should adopt the methods of the engineer. He didn't believe electrical apparatus could effectively be sold without demonstration. We had the duty of educating the public, and except by the E.D.A. the industry has no co-operative advertisement schemes.

Messrs. A. G. Beaver, H. Brown, C. E. Charman, W. Day, A. F. Harmer, H. Marryat, C. Peel, W. E. Rogers, E. E. Sharp, W. E. Warrilow and A. Wise also spoke.

Reviews of Books, &c.

[Books noticed in this column will be sent from Electricity *Office to any part of the world, for the published price, plus ten per cent. for postage (minimum 2d.) and orders will be appreciated.]*

A First Course in Heat Engines. By J. W. Hayward, M.Sc. Second edition. Cl., 8vo, 271 pp., 143 Figs. (Clive, 4s. net.)—This book was originally issued under the title "First Stage Heat Engines" as a first course for students in technical classes, and as such has proved an invaluable aid to a very wide circle of readers. This new edition calls for little comment. The text has been revised where necessary so as to keep it up-to-date, and two small additions have been made dealing respectively with Two-stroke Engines and High Speed Indicators.

Printing Telegraph Systems and Mechanisms. By H. H. Harrison, A.M.I.E.E. Demy 8vo, cl., 435 pp., with 642 diagrams. (Longmans, 21s. net.)—Congratulations to Mr. Harrison on the production of the most comprehensive book on printing telegraph systems which has ever been issued in our language or, so far as we know, in any other language. It is a masterful exposition of the whole subject from the very beginning, and the wealth of clearly drawn diagrams will appeal to every student of telegraphy, telegraph engineer or administration official who is in any way associated with the installation, maintenance or use of such systems. The work is, in fact, the labour of an enthusiast who has devoted years to the study of this particular branch of telegraphy, as indeed is actually the case, and in order to add to its practical value the author has introduced a chapter on the principles of mechanism in general, which is certain to be appreciated by many of its readers. Considerable space is devoted to the transmission of signals, methods of obtaining multiple use of wire plant and the combinations of such methods with machine elements in order to achieve yet fuller means of securing maximum utilisation. It must be remembered that Mr. Harrison writes not only as a recorder of the inventions of other people, but also as an inventor himself. For instance, on page 304 there is a description, accompanied by a diagram on page 305, showing an arrangement designed by him conjointly with Mr. S. R. Smith, and his brain has worked actively in many other sections apart from that one item. Suffice it to say that this book has an assured sale in front of it, as it fills a gap in telegraphic literature which has been open for a very long time.

NEW BOOKS PUBLISHED.

"Costing Organisation for Engineers." By E. W. Workman, B.Sc. Cl. 8vo, 86 pp. Illustrated. 3s. 6d. net.

"Wireless Component Parts, and How to Make Them." By B. E. Jones. Cr. 8vo, 124 pp., 208 figs. 1s. 6d. net.

"A First Course in Heat Engines." By J. W. Hayward, M.Sc. 2nd edition. Cr. 8vo, cloth, 271 pp., 144 illustrations. 4s. net.

"X-Rays." By G. W. C. Kaye, D.Sc. 4th edition. Cl. 8vo, 320 pp., 126 illustrations. 16s. net.

"Printing Telegraph Systems and Mechanism." By H. H. Harrison, A.M.I.E.E. Cl. 8vo, 435 pp., with 642 diagrams. 21s. net.

"Atoms." By J. Perrin. 2nd English edition. Revised. Cl. 8vo, 231 pp. Illustrated. 8s. 6d. net.

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THE GERMAN ELECTRICAL INDUSTRY.

According to the report just received from the British Commercial Secretary at Berlin and dealing with the month of February, in the electrical industry the inland purchasing power is still weak. Neither official nor private customers dare place orders for large plant and machinery. Further, the partial fall of prices is causing some customers to hold back in the hope of further reductions. Foreign countries are, for the most part, showing reserve, in so far as the German prices, which have partly reached the world's market level and partly already exceeded it, admit of any competition. Accordingly, a general falling off in orders is noticeable in high pressure current articles, machinery, apparatus, calculators, installation materials and cables. With regard to measuring instruments and electro-medical apparatus, the position is no better, owing to customers' loss of purchasing power. The outlook for railway safety appliances is bad. The sale of electric lamps at home and abroad shows no improvement, but that of electro-technical coal products is, in general, satisfactory.

THE NEW STANDARD RATING FOR INDUSTRIAL MOTORS AND GENERATORS.

To the scientific mind there is something illogical in saying that the rated output of a machine is so many horse-power (or kilowatts or kilovolt-amperes) and that the machine will withstand an *overload* of so many per cent. for, say, two hours. A simpler and more definite basis of rating would appear to be obtained by saying that a machine would deliver a certain rated output indefinitely without exceeding a specified temperature rise. The existing International Electrotechnical Commission's standard and the British Engineering Standards Association's Report, No. 72, did, in fact, establish a standard rating on this basis, but it is common knowledge that the conditions of service of electrical machinery, and the conditions which have to be met in the competitive sale of these machines, make it more useful to say what load the machine will carry indefinitely without exceeding a certain temperature rise, and what percentage overload it will then carry for a specified (short) period without exceeding a certain (higher, but still safe) temperature rise.

We are pleased to find that the overload system of rating, which is an industrial necessity and has never ceased to be common practice, has now been given official recognition by the British Engineering Standards Association's Report, No. 168.* This specification applies to industrial motors and generators of 1 b.h.p., kw. or kva. and upwards per 1,000 r.p.m., having windings insulated with Class A insulation (cotton, silk, paper or similar materals impregnated or using enamelled wire where applicable). It applies to machines wound for pressures not exceeding 7,000 volts, and does not apply to turbo-type machines, rotary converters and traction motors. Overload requirements for single-phase motors are not yet included. In no case (*i.e.*, not even on overload) may the maximum temperature of the windings or of the cores with which they are in contact exceed 90 deg. C. The sustained overload specified below is permissible only if the temperature of the cooling air does not exceed 30 deg. C. (86 deg. F.).

The *British standard continuous rating* defines the load which can be carried (under the conditions of the rating and of the specification) for an unlimited period without exceeding the limits of temperature rise stated below. The *British standard short time rating* defines the load which can be carried for a specified time (either one hour or half an hour) without exceeding the specified limits of temperature rise.

The limiting rise in temperature (as measured by thermometer) is as follows for motors other than totally enclosed machines, with continuous rating (the bracketed values of temperature rise apply to machines with short time rating and to totally enclosed machines):—Winding and cores with which they are in contact, 40 deg. C. (50 deg. C. for short time rating and totally enclosed machines). Commutators, 45 deg. C. (55 deg. C.). Slip rings, open type, 45 deg. C. (55 deg. C.); enclosed, 55 deg. C. (55 deg. C.). The temperature rise of uninsulated parts and cores not in contact with insulated windings must not be such that there is any risk of injuring the insulation on the adjacent parts.

Machines which are to be used at altitudes exceeding 10,000 ft. above sea level are not considered standard, but between this maximum and an altitude of 3,300 ft. above sea level it is necessary to reduce the permissible temperature rise by 1½ per cent. for each 1,000 ft. above sea level at which the machine is intended to work in service.

Industrial generators and motors (other than single-phase motors) must be capable of sustaining without injury the overloads specified below after having reached the temperature rise corresponding to continuous operation at rated load. As already stated, the maximum temperature of the windings may in no case exceed 90 deg. C. Machines with short time rating and totally enclosed machines are not capable of any sustained overload. Motors and generators having a continuous rating, and of outputs of 4 b.h.p. (or 3 kw. or kva.) or over per 1,000 r.p.m., are to be capable of 25 per cent. sustained overload (*torque* in the case of motors, and *current* in the case of generators) for two hours. If the output per 1,000 r.p.m. is less than stated in the preceding sentence, the sustained overload requirement is 25 per cent. for half an hour.

Machines of all sizes having a continuous rating are to be capable of 50 per cent. momentary overload for one minute if not totally enclosed, and 50 per cent. momentary overload for 15 sec. if totally enclosed. All sizes of machines with short time rating are to be capable of 100 per cent. momentary overload for 30 sec., whether totally enclosed or not.

Such, broadly, are the general provisions of the new British standar specification regardng the rating of industrial motors and generators. For further particulars, and in all cases where it is essential that the exact conditions of the specification should be complied with, the reader should, of course, refer to the complete publication. In common with all the other

*Obtainable from ELECTRICITY Office, price 1s. 2d. net, post free.

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reports issued by the British Engineering Standards Association, this one contains a great deal of valuable practical information, and is, indeed, a miniature text-book of accepted practice on the particular subject to which it applies.

Various Items.

Tenders Invited.—The Cape Town Corpn. invite tenders for 5,000 25-ampere single pole ironclad service cutouts. Specification and blue print at the offices of the D.O.T. (Room 49), 35, Old Queen St., London, S.W.1.

Smoking Concert.—The Faraday House Old Students' Assocn. held its annual smoking concert at the Hotel Cecil on the 22nd inst., Mr P. V. Hunter, C.B.E., M.I.E.E., being in the chair. The attendance broke all previous records, and the musical programme provided was a most excellent one. It followed the third annual dinner of the Faraday House Sports Club.

Moral: Don't be Too Late.—A warning note is sounded by the British Empire Exhibition authorities for the benefit of intending exhibitors who may defer their applications for space until it is too late. U.K. firms desiring to exhibit in the Industrial Hall have been requested to send in their applications before March 31, and so far the response has been so satisfactory that the Exhibition Management have now decided to proceed to the allotment of space on April 30. It is important, therefore, that intending exhibitors should send in their applications without delay. The necessity for allotting space so many months ahead of the opening date arises from the fact that as there are so many sections it is impossible to lay out the exhibition space until it is known what space is required by each section. It can then be equitably apportioned.

Obituary.—We regret to announce the death from pneumonia, on March 5, of Gilbert North, of the Metropolitan-Vickers Co., Ltd. He was a very old servant of the company, having joined the British Westinghouse Co. in 1903. He left them in 1913 and became managing director of the Dickenson Engineering Co. His strenuous work with this firm through the years of the war when labour conditions were so difficult undermined his health, and he was far from well when he rejoined his old firm in November last. Mr. North was an adept at meter design, and many features of the present-day A.C. meter were originated by him. He was a great moral character, and made a marked impression on those with whom he came in contact. He will be sadly missed by his friends and family, to whom we extend our deepest sympathy.

Cardiff.—We have received from Mr. T. W. Dockett Smith, the enterprising manager of the Development Dept. of the City of Cardiff, a well-printed and most interesting book setting forth in clear type the great advantages which that city offers as a manufacturing centre, and how well it is adapted for any big undertaking which may be considering the question of erecting a factory on any particular site and has not yet decided on the exact spot. As the bulk of the population of the United Kingdom has to live on its export trade, it is essential that any factory catering for such trade should be so located as to compete successfully in the world's markets. For this Cardiff can offer cheap power, a plentiful supply of water, and ample transport facilities. We can most cordially recommend all manufacturers and engineers who are interested in this particular question to write to the manager of the Corporation Development Dept. and ask for a copy of the new booklet. It is well worth careful perusal.

Navigation by Wireless.—The first vessel to benefit by the "wireless lighthouse" established by the Marconi Co. on Inchkeith Island, in the Firth of Forth, is the s.s. *Royal Scot*, owned by the London and Edinburgh Shipping Co., Ltd. This boat, which is employed on the London and Leith service, has been fitted with a special type of wireless receiver, which will detect the signals sent out by the "wireless lighthouse" and enable the navigating officer to pick his way through the dangerous channels of the Firth of Forth in the thickest fog. The report on the apparatus is that the "lighthouse" signals were received perfectly during the whole time the vessel was within range, and that the ship's officers were easily able to use the apparatus, which is extremely simple, as only one handle has to be operated. This switches the gear into use, and is also calibrated so as to give a very fair indication of the distance from the shore in addition to the actual bearing. Thus the navigating officer can determine whether he is inside or outside his course.

New Scholarships.—Out of the balance of the I.E.E. War Memorial Fund it has been decided to establish two scholarships, each of the value of £50 per annum and tenable for three years, to provide for the education of children of members who were killed or permanently disabled in the late war. Applications, giving full particulars as to general and financial circumstances, should be addressed to the Secretary of the Institution, Savoy Place, Victoria Embankment, W.C.2.

Trade Notes.

List No. 28 L has been issued by the **Stolzenberg Patent File Co., Ltd.**, of 210, Bishopsgate, London, E.C.2. It deals with the latest pattern of these well-known files, and also with various other files, devices and accessories which will be of interest to business firms generally.

If any trade reader has not yet received a copy of the "Z" catalogue of the Arora electric fires, he should write at once to **The Arora Co.**, Loughborough, and ask for it. It contains a full list of the reduced trade prices.

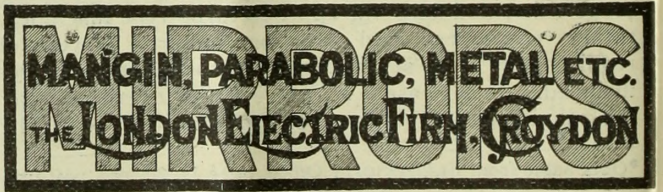
Any reader who wants to have full particulars of some of the latest and best technical books should write to **Chapman and Hall, Ltd.**, the well-known publishers, of 11, Henrietta Street, London, W.C.2, and ask for a copy of their new technical catalogue "Y." It is worth reading.

Henry Wiggin and Co., Ltd. (55, George Street Parade, Birmingham), whose London office and electro-technical department is situate at 3, Staple Inn, Holborn, W.C. 1 (**Lionel Robinson and Co.**), have just issued a compact, handy-sized brochure of 64 pp., full of most useful practical information, on their Snake brand Resistance wires and tapes. The firm has specialised in resistance alloys for the electrical trade for the past twenty years, and many of the products are well known. The list to hand deals with the composition, electrical, physical and mechanical properties of materials for furnaces, cookers and heaters, scientific instruments, commercial instruments, wireless sets, motor-starter regulators and cinema resistances, lamp-making and sparking plugs. The tables are calculated in the new B.S.S., but S.W.G. sizes can be supplied, while special sizes can be made up. The publication may be obtained from either of the above addresses on tendering trade or professional card.

An excellent little descriptive booklet dealing with Rawlplugs and their universal use has just been issued by the **Rawlplug Co.** at 38-42, Lenthall Place, S.W. 7. These plugs can appeal in one way or another to every engineer, with whatever branch of the profession he may be associated, to say nothing of ordinary household use, and we can most strongly recommend every reader of this paper to write at once to the company and ask for a copy of the booklet. It will be willingly sent on application.

In Technical Description No. 235 **The General Electric Co., Ltd.**, provide a fully illustrated description of their oil-immersed draw out flame-proof switchgear for A.C. and D.C. circuits. It is a most interesting and instructive publication, and should be in the hands of all engineers who have to purchase or install this class of apparatus, *i.e.*, those engaged in mines, collieries, steelworks, dockyards, flour mills, etc. It is particularly interesting to note the wide application of this gear, as by means of various switches, instruments and accessories it is possible to arrange either for a pillar to control a single L.T. circuit or a large H.T. board for controlling an extensive system.

From **The Sterling Telephone and Electric Co., Ltd.**, comes Publication No. 345, illustrating their multiple terminal block for radio head telephones. This is a convenient arrangement of metal bars and terminal screws whereby a series of head-phones up to a maximum of six may be connected either all in parallel or in series parallel (two sets each of three pairs) for "listening-in" to broadcasting. The metal fittings are mounted on a base of high-grade insulating material, and there are two screw holes for fixing in any convenient position. The price is moderate.



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A POPULAR SCIENTIFIC WEEKLY JOURNAL
ELECTRICITY
A PRACTICAL TRADE JOURNAL

APRIL 6, 1923.

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DIAGNOSING BRUSH TROUBLES.*

By E. H. Martindale.

[Mr. Martindale has conducted exhaustive original studies on the performance of carbon brushes and has published the results of his findings in various publications from time to time and presented them in an elaborate paper before the American Institute of Electrical Engineers. His practical experience was secured with the Illinois Steel Company, Commonwealth Edison Company and the National Carbon Company. For a number of years he was in charge of the brush testing laboratory of the National Carbon Company.]

Diagnosing carbon brush troubles is not unlike diagnosing an illness of the human body with the added disadvantage that the machine cannot answer your questions. When a patient has the stomach-ache from eating pickles, the doctor can learn by a simple question which one of the 57 varieties his patient has eaten. But in the case of motor or generator the trouble shooter cannot even invoke the magic of the X-ray to guide him in his quest. He must recognise all the possible causes of the trouble and then by the process of elimination determine the source.

A short time ago the editor of the *Industrial Engineer* came to the writer with the request that a short series of articles be prepared dealing with troubles encountered in the operation of carbon brushes. The writer felt rather reluctant to undertake the task mainly for the reason that he had presented the subject at some length during the past eight years in two technical magazines and before the American Institute of Electrical Engineers. Each of these articles was presented from a different view-point and it did not seem possible to write another series which could be materially different from one of the others. It was the editor himself who made the suggestion that an analysis of brush troubles could be presented in chart form for everyday use in studying these troubles in machines. This appealed to the writer as a work that should have been done years ago. He believes it will be of more practical help than any previous method of treating brush troubles.†

A very small percentage of brush troubles is primarily due to the wrong grade of brush. It is true that in any case of trouble a change of brush may prove a great help, but it is like giving morphine to a suffering patient. It has quieted the effect, but does not remove the cause of the trouble.

The carbon brush manufacturers have been too anxious in the past to try to develop a new brush to cure every trouble instead of telling the operator frankly that the machine is at fault. I do not blame the brush manufacturer; he can hardly do otherwise. If he should tell the average operator that the trouble is in the machine, but could not tell him which one of the 46 causes was responsible for his trouble, the operator would think the manufacturer was only trying to shift the blame from the brushes. He would probably call in another manufacturer, get a set of brushes from him, and then he would be sure the first manufacturer was shifting the blame because the second man gave the machine the right dose of morphine.

Four Grades of Brushes are Sufficient in Most Cases.

Four grades of brushes, excluding metal or metal composition brushes, should be sufficient for any plant if the equipment is kept in good condition. If brush manufacturers would adopt a brush letter code, somewhat like the following, for their trouble grades, it might have a salutary effect:—

I. B. S.—For incorrect brush spacing.
B. O. E. N.—For brushes off electrical neutral.
U. B. P.—For unequal brush pressure.
H. B.—For high bars.
D. A. M. N.—Designed for any machine neglected.

I have seen many a maintenance man who had been getting poor service from brushes, without complaint to the brush manufacturer, call in a competitor, follow his recommendation of grinding the commutator, undercutting the mica, adjusting his brush spacing and brush tension, put on the new brushes and never give the old manufacturer another chance at analysing the trouble when all the benefit was from the change in his operating conditions.

It is important that the meaning of several brush terms frequently used should be thoroughly understood when selecting brushes. Brush resistance is practically negligible as it averages only about 1-10th of the contact resistance. Carrying capacity is determined by the combination of contact drop and friction. There are, therefore, only three inherent characteristics of brushes which materially affect their operation, namely: (1) Abrasiveness; (2) coefficient of friction, and (3) contact drop. The first two are mechanical, the last electrical.

Abrasive action should not be confused with hardness. The abrasiveness of a brush depends on its impurities, which usually consist of mica, quartz, silica or iron oxide. A very hard brush free from impurities will not wear a commutator, while a very soft graphite brush with a small percentage of impurities will produce rapid commutator wear.

* *Industrial Engineer*, Chicago.

† We regret space does not permit us to reproduce the chart.

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An abrasive brush will always have a high coefficient of friction, but brushes may also have a high coefficient of friction without being abrasive.

In the chart it is noted that too much abrasiveness is indicated by commutator wear with a bright raw copper surface, noisy brushes, rapid brush wear and commutator heating. The first effect is sure to be present, while the others may be present in a smaller or greater degree depending on the construction of the machine and the wearing qualities of the brush.

Too little abrasive action will be evidenced by high mica, a black commutator and commutator heating. Undercutting the mica may stop all of the trouble and is better than using abrasive brushes which will wear the commutator.

Commutator heating may be produced by brushes with either too great or too little abrasive action. In the former case the heating is due to friction, while in the latter case it is due to burning caused from poor contact between the brushes and commutator.

Large Amount of Power Consumed by High Friction Brushes.

High friction brushes are usually noisy and produce commutator heating. Unless one has figured the amount of power consumed by high friction brushes he may be surprised at the loss caused by this characteristic. In an article published several years ago, the writer showed where on a 100-kw., 220-volt generator, the annual loss from high friction brushes amounted to $277.20 as compared to $37.08 with low friction brushes. These figures were based on an 8-hour day, 300 days per year, with a power cost of 1½ cents per kilowatt hour. There is little excuse for high friction brushes unless abrasive action is necessary. It is better to have a brush with too little abrasive action and stone the commutator occasionally than to have a brush with too much abrasive action. The saving in friction loss will pay for the stones used many times over. The total commutator wear will be less and the reduced heating will permit a higher load on the machines.

Effects of Too High and Too Low Contact Drop.

Too high contact drop in brushes will produce under-commutation with some commutator heating and a small amount of sparking, but these effects are seldom sufficient to cause serious trouble except on low voltage equipment, such as plating generators.

Too low contact drop has more serious effects as it permits over-commutation causing heavy short circuit currents in the coils undergoing commutation, or in other words, in each armature coil as the commutator bar connected to it passes under a brush. This causes both commutator and armature heating, severe sparking with all its attendant evils and in severe cases glowing and pitting of the faces of the brush.

The grade of brush installed on a new machine may be the best when the machine is new, but as bearings, brush-holders and commutator become worn, causing respectively variation in air gaps, setting and spacing of brushes, and an increase in the number of bars spanned by a brush, it may be necessary to change to one with higher contact drop. Usually the motor and generator manufacturer takes all these conditions into account when selecting the brushes for a machine.

All of the brush manufacturers maintain a highly skilled staff of engineers who are glad to assist in the selection of the proper brushes for equipment. Their services are free and their experience should be drawn upon by any industrial plant man who carries the responsibility of selection of brushes and their satisfactory operation.

DEVELOPMENT OF PUBLIC ELECTRICAL SUPPLY IN GREAT BRITAIN.

By C. H. Wordingham, C.B.E., A.K.C., Etc.

(*Concluded from page 170.*)

All the areas so far delimited by the Commissioners have been large ones, but it does not follow that the schemes for dealing with the complete area necessarily provide for the supply of energy to every part of the area, still less does it follow that the supply will necessarily be given from a single capital station, or even from a few such stations. While the Commissioners undoubtedly are strongly impressed with the advantages of concentration of plant and transmission over long distances, they are by no means tied to this idea, and they are quite open to conviction that other means in certain cases may be desirable. In a number of areas there are portions or individual towns which are so isolated that, even though the cost of generation is considerably higher than in a capital station, it is cheaper to employ a local station than to transmit the cheaply produced energy over long distances, and in such cases the isolated town or area would be allowed to have its own relatively small station.

Probably the chief reason underlying the policy of the Commissioners in delimiting such large areas is the decentralisation of the work of supervision with which they are charged. All extensions within the area have first to be considered by the joint electricity authority or other body set up for that area, and after scrutiny by that body they are passed on to the Commissioners. If a large number of relatively small areas were delimited, the whole preliminary work, as well as the final decision, would fall upon the Commissioners and would probably completely overwhelm them.

I have said that the controlling body set up in an area may take the form either of a joint electricity authority or of an advisory committee. The former is undoubtedly that contemplated by the Acts and favoured by the Commissioners. An authority of this kind is given very extensive powers and is enabled to acquire existing generating stations and transmission lines, as well as to erect new stations and provide new mains. Such an authority would produce the whole of the energy required and retail it in bulk to the authorised distributors operating in the area.

No doubt this concentration of control over the whole means of production in the one authority would enable the greatest economy of capital expenditure to be realised and the most efficient operation of the generating plant and transmission mains to be secured, but the capital expenditure necessary to acquire the stations and mains is so extremely heavy that both local authorities and companies have hesitated to commit themselves to raising the capital.

Another deterrent to the setting up of these joint authorities is the fact that they have no powers to compel any of the owners of stations or mains to part

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with them, and in the absence of such compulsory powers the difficulties of effecting the necessary agreements are very great.

As a result of these adverse influences it has been proposed and approved to set up so-called "advisory committees." These committees will not ordinarily acquire either generating stations or transmission mains, but, subject to the consent of the various undertakers, they will control all the extensions and modifications to generating stations and transmission mains in their area and will do a good deal of the work that a joint authority would carry out, but their work can only proceed by consent, and they cannot in any case exercise such effectual control as would a joint electricity authority.

The position of the power companies under this new regime is a somewhat uncertain and difficult one. In point of fact they already have many of the powers that a joint authority would have, and it ought to be possible for them to fill a very useful place in the various schemes. On the other hand, the argument is advanced, and in many instances strongly pressed, that, inasmuch as they have been given twenty years in which to show what they can do, and in that time they have done so little, they ought not to be relied upon for the future, and that, in preference, the large municipalities should be entrusted with the provision of the works required to give effect to the new proposals. There is much to be said in favour of this view, because undoubtedly many municipalities have shown much enterprise and initiative within their own sphere and with the credit of the rates behind them can, and presumably always will be able to, raise capital on more favourable terms than companies can. The matter is one of strong controversy at the present moment, and I do not wish to enter into a detailed discussion of the matter here, but a great deal must inevitably turn upon whether the parties are really in earnest in their professions; at the several inquiries, both companies and municipalities are prepared to enter into very heavy capital commitments, but whether, when the schemes are approved, either the one or the other will be eager to find the money required to carry them out remains to be seen.

Whatever the precise extent of the development during the next decade, there can be little doubt that there will be a number of capital stations established either as entirely new ones or as the development of existing efficient stations, and many authorities now generating their energy on a small scale will cease to do so and will take supplies in bulk. Economy is certain to be effected by this course in many instances, and a number of districts will be enabled to have the advantages of an electricity supply which otherwise it would have had to pay a prohibitive price for or to go without.

It must not, however, be assumed that in every case the bulk supply will be cheapest. It must be borne in mind that the real matter of importance is the cost of the unit delivered to the consumer. It may be assumed that the cost of distribution within the local area will be practically the same whatever the source of the energy distributed, and in most cases the cost of this distribution will mean a substantial sum per unit for distribution alone which must be added to the cost of energy delivered in bulk or generated locally.

The price of the energy to the distributing authority is made up of the cost of generation per unit sent out from the capital station and of the cost of the transmission from that capital station to the area in which the energy is distributed. It is of no use to have cheap generation if the transmission costs are so heavy as to make the cost of the unit delivered to the distributor higher than the cost of local generation. In a number of instances a bulk supply, when the transmission costs are taken into account, will actually be more costly than a supply generated locally with small, expensive and relatively inefficient plant, and, in spite of these drawbacks, the latter is then to be preferred to the taking of a bulk supply. In such cases it is inevitable that the cost to the consumer should be high, and it must be recognised that there are parts of the country in which, while an abundant supply may be given, it cannot be a cheap supply.

When a bulk supply is available the question often arises as to whether the distribution should be undertaken by the local authority or whether the bulk suppliers should carry out the distribution as well as furnish the energy. While possibly some economy of staff may be effected by allowing a larger body to deal with the distribution, there are very strong reasons in favour of the local authority undertaking this portion of the work. Intimate local knowledge of the consumers in the area and of local requirements is important. Again, there are advantages in the control of the opening of the streets being retained in the local authority's hands, but to my mind the strongest reason is in connection with the extension of the mains in various parts of the area. An outside body will only be disposed to lay mains in those portions of the district which are certain to pay and yield the greatest revenue, whereas a local authority, while taking these matters fully into consideration, will also be swayed by a desire to improve the amenities of the district and to give the benefits of the electrical supply to the greatest number of its ratepayers. For this reason I think, as a general rule, the distribution is best committed to individual local authorities.

Underlying the foregoing sketch of the lines on which the supply industry is likely to develop in the immediate future is, of course, the assumption that the present means of generation will persist. It is quite conceivable, however, that they may be radically altered. Three-phase alternating current necessarily involves many difficulties and complications, and there are those who see great possibilities in the simpler and, at all events temporarily, discredited single-phase alternating current, and others again who would not exclude extra high pressure direct current.

Again, good as it is, the steam turbine is far from being the most efficient prime mover, and it is possible that internal combustion engines of large size may be so cheapened in first cost as to compete with steam plant, or gas turbines even may be evolved which would be practicable for use in capital stations.

Were any such radical alteration in prime mover to be effected, the whole aspect of the problem would be profoundly modified. There would no longer be any need to place the generating station near a copious supply of condensing water, and one of the principal arguments for concentration in large stations would have vanished. There is no time to enter into a consideration of the nature of the modifications involved, and it would be largely futile to do so without knowing

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precisely what modifications in practice were to be introduced. This general observation, however, may be made that the possibility of radical changes in practice ought not to interfere with the immediate taking in hand of the improvement of the supply with the tried means which we have at present. All progress must necessarily be a process of evolution, and we can do no more than advance by steps of such magnitude as are within our grasp over ground which is within sight.

THE EFFICIENCY OF ARTIFICIAL ILLUMINANTS.

A paper read recently by Gerhardt before the Association of Architects and Engineers in Berlin calls attention to the remarkable developments effected in illuminating engineering during the past generation or so. The progress is the more remarkable when one considers the thousands of years required to bring the art of artificial illumination up to the standard which satisfied our grandparents, but which was even then lamentably insufficient according to present-day standards. A salutary check is, however, placed upon our self-satisfaction by the figures in the accompanying table, which show the extraordinarily low absolute efficiency of even the best modern illuminants :—

Source of light.	Candle-power hours per lb. of coal.	Absolute efficiency per cent.
Ideal	240,000	100.0
Vertical incandescent gas ...	65	0.027
Inverted incandescent gas...	83	0.034
Carbon filament lamp ...	93	0.039
Metal filament lamp ...	265	0.109
D.C. arc lamp	315	0.13
Gasfilled lamp	547	0.23
Mercury vapour lamp ...	637	0.27
Flame arc lamp	772	0.33
Quartz lamp	1,180	0.5
Glow discharge lamp ...	25	0.01
Neon lamp	590	0.25

Theoretically the energy contained by one pound of coal should be capable of yielding about 240,000 candle-power hours of lighting. This result cannot, of course, ever be attained in practice, because starting from coal we have first to convert this to gas or electricity, and then to produce light by raising refractory materials to incandescence. Due to the losses, mainly inevitable, in the conversion of heat to mechanical energy by the steam-engine cycle, only about 8 per cent. of the thermal value of the coal is realised in the electrical energy delivered from the average small or medium sized central station. In large stations better results are obtained, but nothing can alter the fact that gas is fundamentally in a more favourable position in that it is produced from coal by a relatively cheap process of distillation, the residues and by-products (coke, tar, etc.) all having a market value.

Whether the energy for producing light by incandescence is in the form of gas or electricity, most of the heat developed is radiated as invisible rays. Only a small fraction of the total radiation is visible—*i.e.*, in the form of light—and this is a serious cause of inefficiency which is inseparable from any method of producing light by incandescence. In this respect the production of cold light by phosphorescence, etc., is at a great advantage, but it is not yet possible to produce light by this means on a commercial scale.

Though electricity is necessarily more costly than gas as a source of heat derived primarily from coal, it is considerably more efficient than gas as regards final results, because the losses between electricity and light are very much less than between gas and light. It is for this reason that electric filament lamps have anything from three to ten times the absolute efficiency of incandescent gas lamps (see table above).

We are still a long way below the ideal source of light, the efficiency of which would be about 64 c.p. per watt, but steady progress is being made towards this goal, and in the meantime the economic advantages of electric light are being realised ever more widely. These advantages are even greater than might at first sight appear to be the case, because the efficiency in application of any luminous source can be greatly increased by the use of suitable reflectors, and electric lamps are, of course, easily applied to the theoretically correct form of reflector, whereas a gas flame must be used with a fitting of such form and location that the heat from the flame does not rapidly destroy the fitting. For this reason, scientific illumination as understood and practised by electrical engineers is virtually non-existent in the field of gas lighting.

THE JOURNALIST AND ARCHITECTURE.

At meetings of the Circle of Scientific, Technical and Trade Journalists interesting discussions are frequent, but the gathering addressed by Prof. Beresford Pite on March 20 was a particularly successful one.

Professor Pite gave a most fascinating account of the way in which the history of a country is engraved in its architecture, so that the eminently successful architect is one who is able to express the spirit of his own time. People often refer to the "grandeur that was Rome," and compare modern buildings with those of past ages. But to-day a building suited for a free community must differ from the dominating masses of stone expressive of Roman Imperialism.

The lecturer contended that the message conveyed by fine buildings and their mysterious and elevating effect on the mind cannot be readily expressed by mere verbal description. But it is most useful for journalists to gain some insight into the circumstances determining the trend of architecture, and to realise something of the principles by which architects are guided. A very happy definition of the artist as one who found a joy in his work was given by Mr. Herbert Wills, and endorsed by the lecturer, who pointed out that the humblest worker could be an artist in this sense.

It was announced that the next meeting would be held on May 1, when an address on "The Press and Industry" would be given by Mr. G. J. Wardle (late Parliamentary Secretary to the Ministry of Labour).

Two new circulars from the **E.D.A.** deal respectively with the conditions of electric driving as extracted from a lecture delivered by Mr. Crowley before the Society of Arts and with the effect of the electric light on eyesight. The latter will appeal directly to all contractors and electricity supply engineers, and help them to meet the challenge that the electric light has an injurious effect. Both pamphlets should most certainly be obtained by all interested readers.

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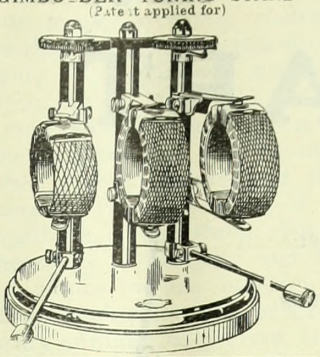
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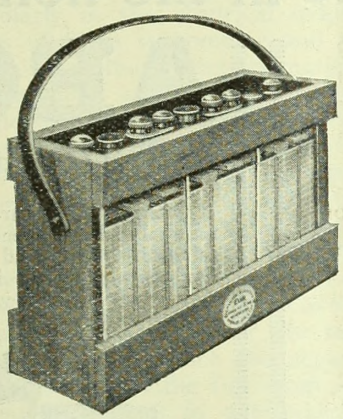
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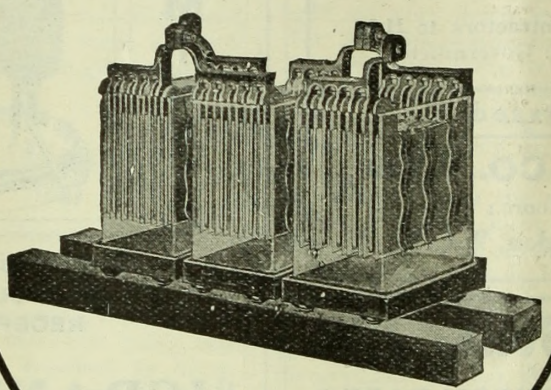
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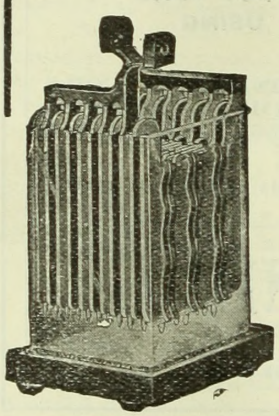
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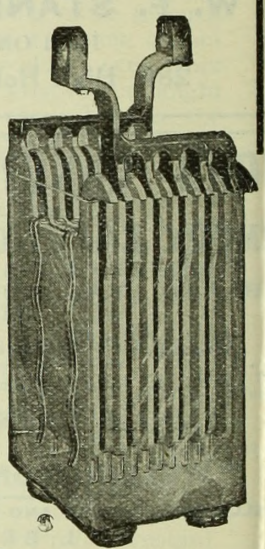
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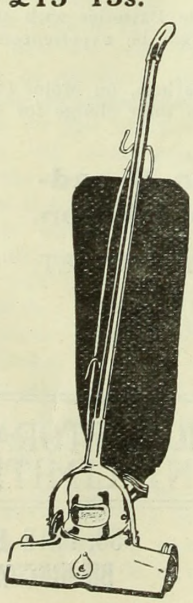
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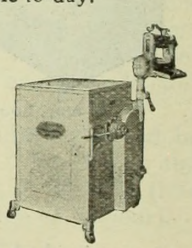
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Current Topics.

Socialistic Fallacies.

The nation as a whole should be duly grateful to Sir A. Mond for his clear and fearless exposure of the fallacies underlying the doctrine of Socialism as expounded in the House of Commons by Mr. Philip Snowden. Not content with the glaring example of Russia before them, the Labour Party extremists have now laid their cards on the table and the country knows what to expect in the event of a Labour Government coming into power. That moth-eaten theory of a non-capitalistic State has been exploded time after time, both by precept and practice, yet its devotees still maintain their misguided campaign which aims at the extinction of all capital and the nationalisation of everything. There is no necessity to go over the ground again; most readers will already have digested Sir Alfred Mond's speech, and will appreciate the fallacies which it so skilfully exposed. There was, however, one passage in it which supports a theory I have held for some time past, viz., that industrial and business organisations have their limiting dimensions from the standpoint of economics, organisation, and management.

Of late years the tendency in many trades, and more particularly in the electrical industry, has been for groups of firms to combine and pool their interests, the idea being that such combinations tend to eliminate much wasteful competition, make for better trading conditions, assist in rendering each group self-supporting, facilitate the bulk purchase of raw materials, and generally reduce overhead expenses. In a measure some of these desiderata are achieved by well-considered amalgamations of similar or associated interests, but there is undoubtedly a limit to the economic size of such organisations, and also to the classes of undertaking which can be thus effectively grouped. For example, I know of one or two large combinations of this character in which the separate works are not yet fully aware of the full range of products of their associated partners in enterprise, and, as a result, cases have occurred of tenders being invited from independent sources for goods which were actually manufactured and could have been supplied just as cheaply, if not more so, by another member of the same group issuing the inquiry.

Touching on this subject, Sir A. Mond, who has had considerable experience of grouping in the chemical trades, instanced the case of an American trust which, when dissolved under Mr. Roosevelt's administration, made more money in the aggregate through the independent trading of the component undertakings in competition one with the other than when united as a trust, simply because in its former state of combination it had outgrown proper economic management, and become so large that the company resembled a Government Department, so complicated and so full of red tape that paralysis set in. Signs are not wanting that a similar fate may overtake one or two of the larger and more unwieldy groups in this country if a limit is not set to their amalgamations and absorptions of smaller competitors. The elimination of wasteful and cut-throat competition is one thing, but the creation of a virtual monopoly is another, and by no means healthy state of affairs for any industry. Sane and healthy competition makes for sure progress, affording just that necessary stimulus to prevent an industry becoming moribund.

Broadcasting.

There has been much ado in the daily Press during the past weeks over the alleged misdeeds of those hundreds of wireless amateurs who are said to be enjoying the entertainments provided by the British Broadcasting Company free of charge, since they contribute nothing to the coffers of that concern through the medium of royalties on home-made sets for broadcast reception. The B.B.C. is stated to be at its wit's end to discover a remedy for this anomalous state of affairs and to secure an equitable share of support from those whose licences entitle them to use sets of their own construction and which do not bear the seal of approval of the Postmaster-General. Various remedies, all more or less impracticable, have been suggested, but so far I cannot recall having seen any reference to what would appear the very obvious way out of the difficulty.

At present holders of broadcast licences contribute their quota on the various approved sets they purchase and use for the reception of the B.B.C. entertainments, the appropriate royalty being paid by the manufacturer on each set sold, and incorporated in the price paid by the licensee. Holders of "experimental" licences, on the other hand, only contribute the very nominal licence fee of ten shillings, a portion of which is paid over by the P.M.G. in aid of B.B.C. revenue. Now the vital factor of every receiving set is the thermionic valve or valves, without which all apparatus would be useless except for "close up" reception. Why not, therefore, impose an appropriate royalty, payable to the B.B.C., on every valve sold, whether for use in experimental or approved sets? The "experimentalist" would then be on an equal footing with the genuine holder of a broadcast licence, and, moreover, both would pay proportionately to the amplifying power of their sets.

The suggestion could be amplified, if need be, by the inclusion of smaller royalties on both head telephones and loud speakers, both of which already contribute their quota in connection with "approved" sets. The scheme, however, has this advantage, that neither valves, head phones, nor loud speakers can be readily constructed by the average amateur, being by their complex nature rather beyond his capabilities. It is these accessories which ninety per cent. or more of listeners-in in either category are forced to buy, and, given an equitable royalty arrangement they would automatically contribute their quota to the cost of the broadcasting entertainments. The appropriate tax could be collected at the source by the manufacturer

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of all three components, who would make his returns to the B.B.C. at appropriate intervals. Any imagined difficulty arising out of valve breakages or replacements could be readily overcome by making it incumbent on the purchaser of a replacement to bring his defective valve to the dealer as a certificate of payment of royalty. The scheme would appear as simple of application and as equitable as the direct petrol tax for motor vehicles, which all the motoring organisations are endeavouring to restore in place of the unpopular and highly inequitable horse-power tax.

Those Dilatory Meters.

Electricity consumers at Torquay are on the horns of a dilemma. Their last quarter's accounts for energy consumed were double and in some cases treble the amounts of the corresponding quarter of last year. Consequently certain tradesmen in the town who are fairly large consumers of electricity have withheld payment of their accounts pending an investigation into the cause of the increases. Recently they received notices from the Borough Treasurer informing them that unless they paid their accounts forthwith the supply of current would be cut off. According to a statement from the Electricity Department the trouble is due to certain old meters being sluggish in their action, as a result of which consumers received more current than the amount recorded against them by meter. If such be indeed the case, the Electricity Department would appear to have no case against the recalcitrant consumers since it provides the meters and is responsible for their commercial accuracy. The most graceful way out of the *impasse* would be for the department to cry quits on the actual meter readings, and see that the slow meters are replaced before next quarter's accounts come due.

A Sweeping Assertion.

About a fortnight ago, when Mr. Snowden's socialistic motion was first before the House of Commons, I saw in a widely circulated evening paper a letter over the initials A. A. B. from which I make the following abstract :—

"In normal times Mr. Snowden's motion would have been drowned in laughter. But to-day there are hundreds of thousands kept out of employment by the trade unionist scale of wages, and even the middle classes (always excepting the shopkeepers) are cross and hungry, and wondering whether, as their condition could not be worse, any change could make it better."

That is a fairly frank statement, and I am wondering if any staunch trade unionist has replied to it in any way. The accusation certainly cannot apply to the engineering trade. Goodness knows skilled engineers are not drawing the wages paid to scavengers in Poplar and many other towns, while miners also are suffering from a big handicap. Perhaps A. A. B. really refers to the shocking inequalities of wages in different trades. If so, I can admit he may have a certain amount of basis for his statement. For instance, in two trades with which I am acquainted, the high wages at a rate much in excess of the cost of living ratio are causing work to be driven from London to the country, and even to Germany. All who have orders to give out or enterprise to develope are holding things up and living in a sense from hand to mouth. Such a policy does certainly tend to maintain unemployment, but the controlling unions seem quite delighted over it.

Elektron.

PYROMETERS AND DISTANCE THERMOMETERS.

For the measurement of high temperatures (above 600 deg. C.) Siemens Bros. and Co., Ltd. (Woolwich, S.E.18), have designed an optical pyrometer which works on the principle that the heated object of which the temperature is to be measured is observed through a telescope, and its brightness compared with that of a standard electric lamp fitted inside the telescope. As the temperature of the lamp varies with the current, which can be most accurately measured on the ammeter provided, it follows that as the scale is calibrated in deg. C. instead of amperes the temperature can be obtained at a glance. The entire apparatus, with accessories, is shown in Fig. 1, while Fig 2 shows the image of the lamp filament superimposed on the heated body as seen through the telescope. The brightness of the lamp is controlled by two adjustable resistances mounted on the telescope, and Fig 3 shows the adjustment correctly made so that the brightness both of the filament and the hot body are the same. If the current is further increased, the filament will again appear bright on a comparatively dull background. Full details of this pyrometer and its uses may be obtained from Messrs. Siemens, who also have available literature descriptive of their electrical distance thermometers for cold storage chambers in ships and for measuring temperatures from minus 200 deg. C. up to 500 deg. C.

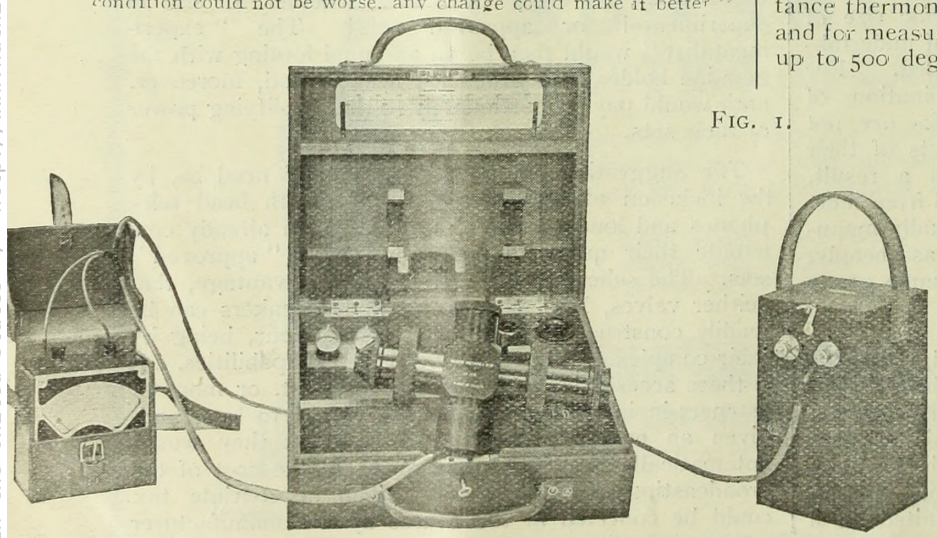


Fig. 1.

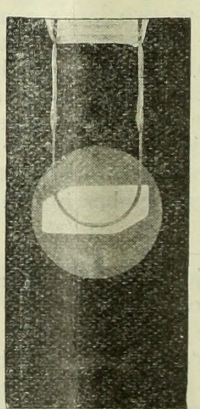


Fig. 2.

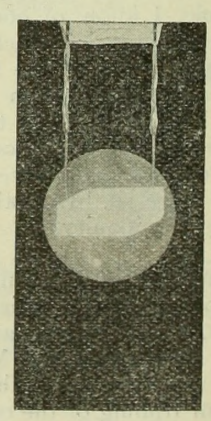


Fig. 3.

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SOME TRAIN LIGHTING SYSTEMS.*

By Cyril T. Cocks.

(*Continued from page* 160.)

The friction gear comprises two hardwood blocks which ride on a grooved ring against the tension of two spring plungers.

The friction is sufficiently positive in its action to move the rocking arm round to the stops.

As the speed of rotation increases and the rocking arm is automatically locked by contacts being in mesh, the friction blocks fly out by centrifugal force, thereby minimising wear and friction losses, as the required friction is only necessary to affect a throw-over of the rocking arm in the event of a change in the direction of train movement.

Fig. 3 illustrates the three positions of the switch-board contacts on the Gill type dynamo. As previously explained, the centrifugal force exerted on the governor gear at the end of the armature shaft causes the rocking arm to move forward towards the five contacts. It will be seen that before the contact comb A makes contact with contact 5, it acts as a medium in joining up contacts 1, 2, 3 and 4.

This closes the field circuit of the machine, which then becomes separately excited from the battery, the current flowing as shown in Fig. 3 (a). On the rocking arm moving further forward, contact 5 comes into circuit, joining up the armature circuit with that of the battery, so that from this moment the machine is self-excited, and at the same time commences to charge, see Fig. 3 (c).

Immediately after contact 5 has been joined into circuit a mechanically operated finger or short-circuiting lever opens up the resistance in circuit with the lamps, so that as the battery receives its charge, and its voltage correspondingly rises, the increased pressure is prevented from reaching the lamp circuit.

* Abstracted from the *Transactions of the South African Institute of Electrical Engineers.*

Having thus described the Gill machine, reference will now be made to what is known as the "Liliput" machine. The mechanically operated switch used in the "Gill" type of machine is, in the author's opinion, as near perfection as a mechanical contrivance can be. Yet an apparent weakness exists, that is, the possibility of the machine cutting into the battery before the generated pressure is sufficient to overcome the battery pressure, causing, at least, a momentary "kick" or heavy discharge from the battery. Although in actual practice this has seldom occurred, the possibility still exists.

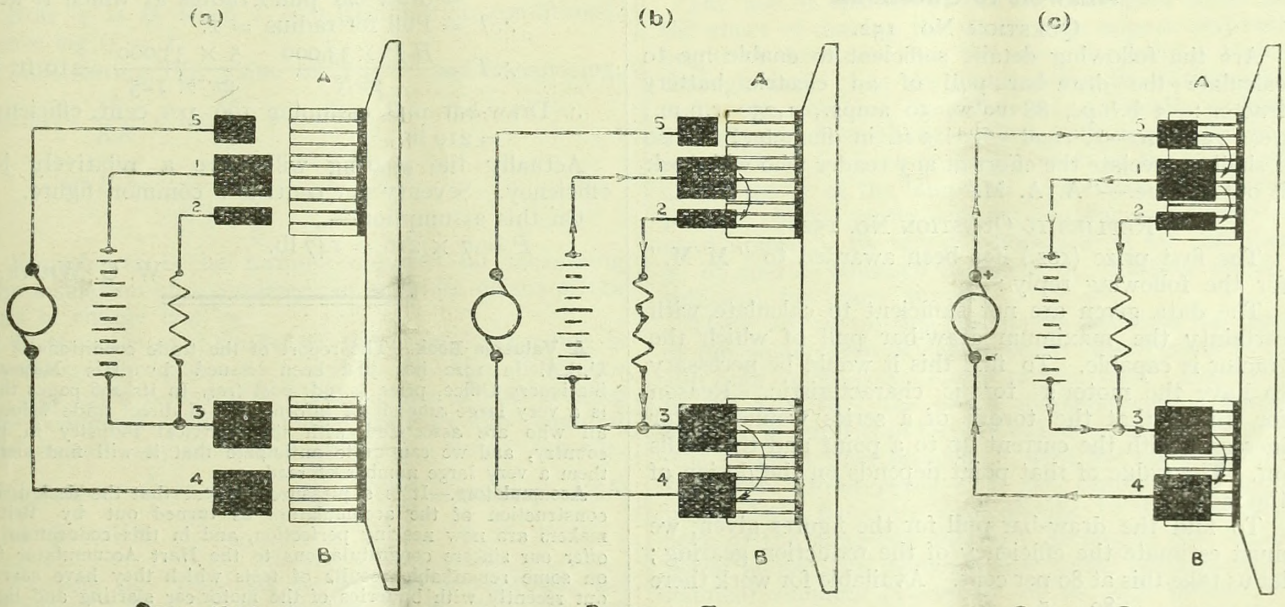
The eliminating of this possibility is the predominant feature of the Liliput machine.

The Liliput machine, unlike its predecessor, is self-exciting, and calls for no special design in gear for the purpose of controlling the making and breaking of the field circuit. The cutting in and out operations are electrically controlled, and the initial current to the cells on commencement of charge is rendered constant, and as near zero as possible. In the Gill machine it will be remembered that the "cut-in" depended entirely on the centrifugal force due to r.p.m. of dynamo. It will be seen, then, that should the Gill machine fail electrically, the "cut-in" switch would still operate, with disastrous results to both cells and the various contacts.

The Liliput equipment being electrically controlled, it is solely dependent on the brush voltage of the machine, so that, in the event of a failure occurring, the "cut-in" switch would fail to operate, thereby automatically protecting the whole installation.

Auto Cut-in Switch.

This switch (shown in the lower left-hand corner of Fig. 2) is of standard design for all sizes of Liliput machines, and is designed to operate as follows: When the dynamo voltage rises to the correct value for charging, the shunt coil lifts the armature which closes the main circuit to the cells and energises the series coil, which in turn holds the switch contacts firmly



Open Circuit. Battery Field. Closed Circuit.

Fig. 3.

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together against train vibration. Both shunt and series fields are now compounding. When the machine slows down, however, the current in the series coil diminishes, while the shunt current remains fairly constant, until eventually the battery sends a reverse current through the series winding, throwing the armature "off" and cutting the dynamo out of circuit.

(To be continued.)

Questions and Answers by Practical Men.

RULES.

QUESTIONS: *We invite our readers to send us questions, preferably on technical problems that have arisen in actual practice. Questions which we consider of sufficient interest to our readers will either be replied to under "Answers to Correspondents" or replies will be invited from our readers. One shilling will be paid for the question which we select for competitive replies in this column.*

ANSWERS: *A fee of 10s. will be paid for the answer which we consider shows the greatest merit, and 5s. for the one we select as second best. In judging the replies, importance will be attached to clearness and conciseness, as well as accuracy. The Editor reserves the right to make no award, or to accept only one reply, if, in his opinion, the answers received do not possess sufficient merit. Competitors desiring the return of their manuscripts, if unaccepted, should enclose stamped addressed envelope.*

Write on one side of the paper only, and if diagrams are sent, draw them on a separate sheet of paper attached to the manuscript. Competitors may adopt a "nom de plume," but, both in the case of questions and answers, the competitor's real name and address must be sent with the manuscript as a guarantee of good faith. No correspondence will be entered into with regard to successful replies. The Editor's decision is final.

Commencing with Question No. 101, a Diploma of Merit will be awarded to the six competitors who win the first or second prize the most times during the next twelve months.

The words "Questions and Answers" or "Q" and "A" should be placed at the top left-hand corner of all letters intended for this column.

Question No. 157.

Can any reader give me details from which I can make a Nodon Valve to enable me to charge accumulators from an A.C. supply? What is the action of such a valve?—"Wireless."

Question No. 158.

I have to repair a number of accumulators. My difficulty is that I do not know how to connect the bridge pieces, that is, the bars which are connected across the top of each set of plates. I understand that these are "burnt" on. How is this done?—"Accumulator."

(Replies to Questions 157 and 158 must be received not later than April 28, 1923.)

Answers to Questions.

Question No. 152.

Are the following details sufficient to enable me to calculate the draw-bar pull of an electric battery tractor:—5 b.h.p., 88 volts, 50 amps., 1,250 r.p.m., gear ratio 10—1, road wheel 2 ft. in diameter? If so I shall appreciate the effort of any reader who will work it out for me.—"A. A. M."

Replies to Question No. 152.

The first prize (10s.) has been awarded to "M. M." for the following reply:—

The data given are not sufficient to calculate with certainty the maximum draw-bar pull of which the tractor is capable. To find this it would be necessary to have the motor's torque characteristic. Reason for this is that the torque of a series wound motor increases with the current up to a point and then falls off. The value of that point depends on the design of the motor.

To find the draw-bar pull for the figures given, we must estimate the efficiency of the reduction gearing; let us take this at 80 per cent. Available for work there will then be $\frac{80}{100} \times \frac{5}{1} = 4$ horse-power.

As the gear ratio is 10 : 1 the wheels will make 125 revolutions per minute. Lineal speed will therefore

$$= \frac{2 \times 22}{7} \times \frac{125}{1}$$
$$= 785.7 \text{ feet per minute.}$$
$$= 8.97 \text{ miles per hour.}$$

4 horse-power $= 4 \times 33{,}000$ foot lb. minutes.

$$\therefore \text{d.b. pull} = \frac{4 \times 33{,}000}{785.7}$$
$$= 168 \text{ lb. (approx.)}$$

If from the torque characteristic of the motor we find that at the maximum point the torque is 30 per cent. greater than when at normal full load conditions, available horse-power for work will then

$$= \frac{80}{100}\left\{5 + \left(\frac{30}{100} \times \frac{5}{1}\right)\right\}$$
$$= 5.2$$

draw-bar pull then $= \frac{5.2}{4} \times 168$

$$= 218.4 \text{ lb.}$$

When at normal work with a draw-bar pull of 168 lb., and on a road where the traction coefficient is 80 lb. per ton, the tractor will draw a gross weight of 2 tons at nearly 9 miles per hour. "M. M."

The second prize (5s.) has been awarded to "W. G. White" for the following reply:—

The actual draw-bar pull in the case cited will depend to some extent on the efficiency of the gearing.

Assuming 100 per cent. efficiency:—

5 *B.H.P.* = output of motor at shaft and is independent of the current and voltage.

Speed of road wheel $= \frac{1}{10} \times 1{,}250 = 125$ r.p.m.

Radius of road wheel = 1 ft.

The horse-power is given by the following expression:—

$$H.P. = \frac{2\pi NT}{33{,}000}$$

where N = speed in r.p.m. of road wheel.

T = torque in lbs. ft.

= draw-bar pull × radius at which it acts.

$\therefore T$ = Pull for radius = 1.

$$\therefore T = \frac{H.P. \times 33{,}000}{2\pi N} = \frac{5 \times 33{,}000}{2\pi \times 125} = 210 \text{ ft. lb.}$$

$\therefore$ Draw-bar pull, assuming 100 per cent. efficiency, = 210 lb.

Actually the gearing will have a relatively low efficiency. Seventy per cent. is a common figure.

On this assumption—

$P = .7 \times 210 = 147$ lb.

W. G. White.

A Valuable Book.—The report of the trade conditions of the U.S.A. in 1922 has just been issued by His Majesty's Stationery Office, price 5s. 9d. post free. In its 206 pages there is a very large amount of information of direct trade value to all who are associated with the electrical industry in this country, and we can quite anticipate that it will find among them a very large number of readers.

Accumulators.—It is a pleasure to hear that the design and construction of the accumulators as turned out by British makers are now nearing perfection, and in this connection we offer our sincere congratulations to the Hart Accumulator Co. on some remarkable results of tests which they have carried out recently with batteries of the motor-car starting and lighting type. They will be pleased to forward details on application.

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TELEGRAPHY.*

Being Solutions to the Questions set by the City and Guilds of London Institute at the Final Grade Examination in Telegraphy held in May, 1922.

Compiled by a Silver Medallist.

(*Continued from page* 166)

Q. 6.—What is the formula used for measuring the insulation of a cable or of a condenser by means of the loss of charge test? Two condensers of 2 microfarads and 1 microfarad capacity respectively are separately charged to 10 volts and left insulated. It is found that the 2-microfarad condenser loses half its charge in 10 seconds, whilst the 1-microfarad condenser loses half its charge in 5 seconds. What are the relative insulation resistances per microfarad of the two condensers?

A.—Consider a condenser of capacity K charged to a potential difference of V volts, and therefore containing a charge $Q = VK$. Suppose the condenser is allowed to discharge through a very high resistance R which may be considered equivalent to its total insulation resistance.

If q is the charge remaining in the condenser after t secs. of discharge, the potential difference between the plates will be $v = \frac{q}{K}$

Moreover, the instantaneous discharge current c at time t, will be $c = \frac{-dq}{dt}$, the minus sign being prefixed because q decreases as t increases.

By Ohm's Law $c = \frac{v}{R}$

Hence $\frac{-dq}{dt} = \frac{q}{KR}$

Integrating we have

$$\log q = \frac{-t}{KR} + A \quad \ldots(1)$$ where A is a constant.

Now $q = Q$ when $t = o$ (the initial conditions), hence $\log Q = A$.

Substituting this value of A in (1) and transposing, we have $\frac{t}{KR} = \log \frac{Q}{q}$

$$\text{or } R = \frac{t}{K \log \frac{Q}{q}} \quad \ldots\ldots (2)$$

Equation (2) is the formula required for measuring the insulation of a condenser or cable by means of the loss of charge test.

In the case of a condenser the general procedure is to charge the plates to a certain potential difference V, say, then remove the charging source and keeping the condenser plates insulated measure the potential difference v, say, between them after a time t seconds. The ratio of $\frac{V}{v}$ is equal to that of $\frac{Q}{q}$ because $q = vK$ and $Q = VK$.

Hence, knowing the ratio $\frac{Q}{q}$, the total insulation resistance R of the condenser may be found by substituting the various values in (2).

Thus, for the 2-microfarad condenser, $t = 10$ secs. $\frac{Q}{q} = 2$, $K = 2$ mfd.

Hence, total insulation resistance $= \frac{10}{2 \log 2}$ megohms, and the insulation resistance per microfarad

$$= \frac{10}{2 \log 2} \times K = \frac{10}{2 \log 2} \times 2 = \frac{10}{\log 2} \quad \ldots (3)$$

Similarly for the 1-microfarad condenser, the total insulation resistance $= \frac{5}{\log 2}$ megohms, and the insulation resistance per microfarad

$$= \frac{5}{\log 2} \times 1 = \frac{5}{\log 2} \quad \ldots\ldots (4).$$

Hence, from (3) and (4) it follows that the insulation resistance per microfarad of the 2-microfarad condenser is twice that of the 1-microfarad condenser.

(To be continued.)

* Consult also "Questions and Solutions in Telegraphy and Telephony," Final Grade, by Few, 2s. 3d. post free from Electricity Office.

CHARACTISTICS OF HIGH CANDLE-POWER GAS-FILLED TUNGSTEN LAMPS.

Interesting information concerning the electrical and optical characteristics of high candle-power gas-filled tungsten lamps is given by M. Pécheux in a recent issue of *Revue Generale de l'Electricite*. From investigations on 100 c.p. argon-filled lamps and on 200, 400, 600 and 1,000 c.p. nitrogen-filled lamps, the author concludes that the horizontal candle-power varies with Vm, where m varies from 1.73 to 3.45 (being generally higher in the lamps of higher candle-power). The principal cause of variations in m is the varying degree of purity of the tungsten employed.

The use of opaline instead of clear glass bulbs has the effect of making the whole bulb appear uniformly bright to the naked eye, but when the lamp is viewed through dark glass the filament can be distinguished easily, showing that the diffusion is not really uniform. The actual effect of the opaline bulb appears to be a reduction of from 15 to 20 per cent. in the horizontal candle-power of the lamp and an increase of about 15 per cent. in the power consumption per mean spherical candle-power. By way of compensation for this there is, of course, obtained a degree of diffusion which is sufficient for many purposes.

There are interesting differences between the forms of the polar curve of candle-power distribution for low and high candle-power lamps respectively. This is due to the fact that the coiled filament sags somewhat between its support in the case of low candle-power lamps (the filament then being fine), with the result that the horizontal candle-power—*i.e.*, the candle-power in the plane of the filament, perpendicular to the axis of the neck of the lamp—is relatively greater in low candle-power lamps than in high candle-power units where the filament remains practically in the one plane. The candle-power below the horizontal is however relatively

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greater, and nearly uniform in all directions below the horizontal in the case of high candle-power lamps.

The author finds that the spherical reduction factor, *i.e.*, the ratio of the mean spherical candle-power to the mean horizontal candle-power, is about 0.98 in the case of lamps from 50 to 400 c.p. in clear or opaline bulbs and 1.04 in the case of 600 and 1,000 c.p. lamps in clear bulbs.

The resistance of the filament at the working temperature is from 15 to 16 times its resistance at 0°C.

Useful formulæ for the consumption of these lamps in watts per bougie-decimale (*Note*—1 bougie-decimale = 1.04 British candle-power) are as follows :—

Gasfilled lamps with clear bulbs—

$$\text{Watts per mean spherical c.p.} = 0.42 + \frac{38}{C} = \frac{910}{C'}$$

Gasfilled lamps with opaline bulbs—

$$\text{Watts per mean spherical c.p.} = 0.62 + \frac{9.8}{C} + \frac{117}{C'}$$

In these formulæ C = the mean spherical candle-power of the lamp. Naturally, the numerical factors in these formulæ vary somewhat with the make of the lamp, but the results calculated from them agreed excellently with the experimental observations of the author.

MOTOR-CONVERTERS.

The two 2,500-kw. self-synchronising Peebles-la Cour motor-converters illustrated were built to the order of the Manchester Corpn. Electricity Dept. Each is designed to operate directly off a three-phase 50-cycle supply at 6,400-6,500 volts on the A.C. end, and to deliver at the D.C. end 5,700 amps. continuously at any pressure between 400 and 440 volts. The fields are shunt wound and each converter deals automatically with an out-of-balance current on the D.C. side up to 1,000 amps. In addition to the foregoing the order included the supply of a 1,500-kw. set of similar type and characteristics.

The manufacturers, Bruce, Peebles and Co., Ltd. (Edinburgh), properly attach a great deal of importance to their works' tests, and every machine is exhaustively tested to ensure everything being entirely satisfactory before being finally finished off and prepared for despatch.

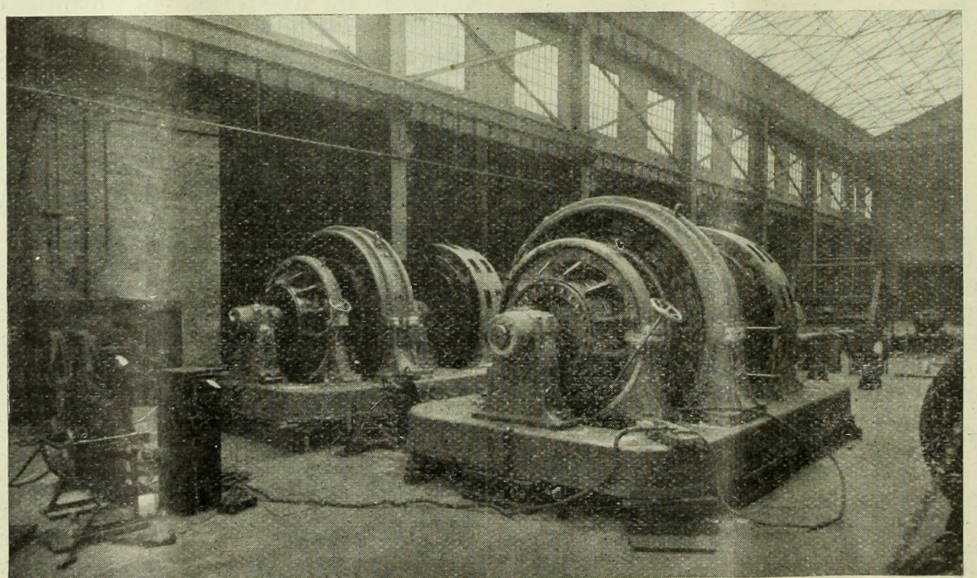
Evidence accumulates as to the increasing use of the Peebles-la Cour motor-converter, and it may be of interest to our readers to learn that the firm have actually supplied to the above authority no fewer than 69 motor-converters with an aggregate capacity of well over 53,000 kw., while they have recently been successful in securing a further order for the supply of two 2,500 kw. sets and a 500 kw. automatically controlled set, thus bringing the total number of converters supplied and on order to 72, and the aggregate capacity to over 58,000 kw.

Various Items.

A Handsome Calendar.—The calendar just issued by the Metropolitan Vickers Co., of Manchester, for the year ending March 31, 1924, is a really beautiful art photograph of Miss Mamie Watson, and will be keenly appreciated by any and every trade client who is so fortunate as to receive a copy. It is an ornament to any office or reception room.

Motor-ships Displacing Steamers.—According to the *Motor Ship*, orders were placed with British yards last month for nine motor-vessels, of 61,000 tons gross, or, if two 17,000-ton liners, of which final details are not yet completed, be included, the total amounts to 95,000 tons gross. This is larger than during any corresponding period within the past two or three years. Much auxiliary electrical machinery will also be required.

Meetings.—The Wireless Section of the I.E.E. will meet in the Lecture Theatre of the Inst. on Wednesday, the 11th inst., at 6 p.m. Subject: "The Application of a Revolving Magnetic Drum to Electric Relays, Siphon Recorders and Radio Transmitting Keys" (experimental demonstration), by N. W. McLachlan, D.Sc. (Eng.) (Member).——The Junior Inst. of Engineers will meet at 39, Victoria St., S.W. 1, on Friday, the 13th inst. Paper: "The Instrument Equipment of Aeroplanes," by C. B. Clapham, B.Sc. (Member). Slides and exhibits. Also on the 20th inst., Lecturette, "The Business of Engineering," by H. N. Munro (Member), and on the 27th inst., Lecturette, "Stock Control," by J. Fearn (Member). All at 7.30 p.m.—— The Scottish Centre of the I.E.E. will meet at the Rooms, 207, Bath St., Glasgow, on Tuesday, the 10th inst., at 7.30 p.m. A paper by the late Dr. Gisbert Kapp, on "The Improvement of Power Factor," will be read by Mr. R. B. Mitchell. There will also be a meeting at the Technical Institute, Dundee, on Friday, the 27th inst., at 7.30 p.m. Paper, "The Drive of Power-station Auxiliaries," by Messrs. Breach and Midgley.



Two 2,500-K.W. Peebles-la Cour Motor-Converters on Test Bed.

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Reviews of Books, &c.

[Books noticed in this column will be sent from Electricity *Office to any part of the world, for the published price, plus ten per cent. for postage (minimum 2d.) and orders will be appreciated.]*

X-Rays. By G. W. C. Kaye, O.B.E. Fourth edition. Cl., 8vo, 320 pp., 126 illustrations. (Longmans, 16s. net.)—From its first issue in 1914, Dr. Kaye's book on this important subject has been looked on as a standard work which should be consulted, studied and thoroughly mastered by all who wish to become efficient in X-ray work. To maintain this reputation has been the author's aim in the editions which have followed since that date, and now a fourth is with us. Needless to say, it has been most carefully revised, and Dr. Kaye has also been able to embody in it much of the substance of his recent lectures at the Royal Institution, the Royal Society of Arts, and the Royal Society of Medicine, more particularly with reference to the applications of X-rays. The value of the book has been increased very materially thereby, and it is certain to find an ever-growing circle of readers. Particular value attaches to the clearness of the diagrams and illustrations, which are of the utmost importance in a work of this character.

The "Rapid" Decimal Calculator and Universal Reckoner. By J. Gall Inglis, F.R.S.E. Size 4⅝ by 3½. (Gall and Inglis; 1s. 6d. net.)—This is a book of 80,000 calculations, and is neither more nor less than a gigantic multiplication table, with every unit up to 100 times 150; and the largest figure 504 times 1,050. Foreign money exchanges, percentages, and even petrol consumption miles per gallon can be easily found from this book; while the multiplication table in itself will save a lot of calculating in making square or cubic measures. Whether a decimal coinage comes into use or not, every business man having calculations to make will find this book a help.

The Electrical Trades' Directory and Handbook, 1923 (41st edition). (Benn Brothers Ltd., 25s.)—Our old friend, the Blue Book, is waxing corpulent, so much so that the title "Handbook" is almost a misnomer; but that very growth in bulk is an important part of its value, because it is due to the growth of our industry and the corresponding increase in the space required to do it justice. Needless to say, no effort has been spared to maintain the reputation which the directory holds in the trade, while the statistical and handbook section has been enlarged by the addition of a chapter on the Post Office regulations regarding wireless broadcasting, as well as an abstract of the 1922 Electricity Supply Act and particulars about the new districts planned out by the Electricity Commissioners. The book is a real "trade necessity."

Electricity in Agriculture. By A. H. Allen. 116 pp., 35 figs. (Pitman, 2s. 6d.).—The author's aim is to indicate as thoroughly as possible in the space at command the various types of service which electricity can render to the farmer; the methods by which he can at once avail himself of those services; and the value of the farmer, as a desirable consumer, to the supply authority. Where a supply is not available hints are given of the approximate cost and type of plant which is most suitable for installation in farms. Most enlightened opinion knows that electro-mechanical aids offer the only solution at the present time for bringing back our vast unfarmed areas to profitable cultivation, but for some reason progress here is appallingly slow, though abroad, particularly perhaps in Germany, by their adoption years ago land is more than twice as productive as in this country. In addition to the simple, well-written text and accompanying illustrations, there are four valuable tables dealing with h.p. required for various services, power consumption, cost of ploughing and consumption of electricity for the purpose. The "Primer" should prove a valuable educative proposition, and we wish it well.

The Text-book on Wireless Telegraphy, Vol. II. Valves and Valve Apparatus. By Rupert Stanley, B.A., LL.D., M.I.E.E. (Longmans. 15s. net.)—From the mass of wireless literature at present being written and published, this book should be welcomed by amateur and professional alike. It is confined to the subject of valves and valve apparatus, which it describes not only clearly and concisely, but very completely. The book in general will be fresh to those familiar with the subject, as information is given on Continental practice and covers wider ground than that usually touched upon by most amateurs. The addition, for instance, of details of many German valves makes fresh and interesting reading, and in spite of the similarity there must be between all diagrams of valve circuits, the writer has introduced small differences in many of his diagrams, which, although they are not of importance, give to the book a little distinction of its own. The uses of the valve, the various methods of valve coupling, are fully and ably described in a manner that shows the author to be fully conversant with his subject. The mathematical side of the problem is reduced to a minimum, and its value is due chiefly to the very practical way in which the information it contains is given. To the wireless amateur, who has covered the usual elementary ground, it is a store of valuable information, and will give him matter for experiment and test, and describes new circuits and conditions he will do well to investigate. The author is to be congratulated also on sticking closely to the subject of the book, and while the theory of the valve is described from the beginning, the usual elementary padding that one gets so tired of is omitted. The information given is of value from cover to cover, and the book is to be strongly recommended, for in buying it, you buy a book essentially practical on valves and valve apparatus, and not a book in which the first half is devoted to general electrical circuits, descriptions of magnetic flux, stones, ponds, ripples, etc. In other words, it is a good book on valves and their circuits.

E.D.A.—The report of the third annual general meeting of the British Electrical Development Association affords pleasant reading to all who are interested in the steady progress of the electrical industry. It sets forth the objects of the Association, the terms of membership, and full details of the work which has been carried out, as well as of the policy which it is intended to pursue, and there is not the slightest doubt that it is having a very beneficial effect on the electrical trade generally. It only remains for it to be supported still more heartily by all the various firms associated with the different branches of the electrical profession.

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Trade Notes.

Wireless readers who are troubled with distortion due to condenser action should write to the **Igranic Electric Co., Ltd.**, at 147, Queen Victoria Street, London, E.C.4, and ask for leaflet Z30, which gives full particulars of the "Igranic" Gimbal Mounted Honeycomb Coils. This will help them to secure perfect tone reception.

A special lock for incandescent lamps has recently been placed on the market by the **Francis Tool and Engineering Co., Ltd.**, of 1A, Overstone Road, Hammersmith, W.6, and they will be very pleased indeed to send a sample lock on request by any regular trade reader. This is an offer which should be followed up.

We have received from **Mr. H. Rhodes**, wholesale electrical factor, of Keswick, a copy of his net monthly price-list of electrical fittings and accessories. This contains details of a large quantity of electrical supplies which will prove of direct interest to contractors, wholesalers, and, indeed, to all connected with the electrical trade, to whom he will be pleased to forward it on application.

From **A. H. Hunt, Ltd.**, "H. A. H." Works, Tunstall Road, Croydon, Surrey, comes an illustrated list of wireless batteries and accessories. This firm markets the well-known Hellesen dry cells for all purposes, in addition to small voltmeters, ammeters and other convenient accessories for the wireless enthusiast.

A special novelty in batteries for wireless broadcasting was exhibited at Stand No. 22 (Ideal Homes Exhibition) by **Messrs. Pritchett and Gold and E.P.S. Company, Ltd.** It is a special "Gravity Float" type of accumulator, which automatically indicates to the user the state of charge or discharge based on the alteration in gravity of the electrolyte. Each battery embodies three "Gravity Floats" of distinctive colours—white, blue and red—so calibrated as to sink successively as the density of the acid falls. For example, the white float will commence to sink when the cell is 50 per cent. discharged; the blue float, when the cell is 75 per cent. discharged, and the red at 95 per cent. exhaustion. The user is thus furnished with an immediate and fairly accurate ampere hour indicator showing the approximate charge remaining in the battery at any time. The plate group of these batteries is of the well-known "Bull-Dog" type, with extra thick positive plates, and perforated ebonite separators, a construction making for hard wear and resistance to disintegration.

Leaflets 66B and 71 respectively from **Messrs. Gent and Co., Ltd.**, Faraday Works, Leicester, deal with their broadcasting accessories and complete receiving sets. For their head-dress 'phones, Messrs. Gent and Co. claim high efficiency, ease of adjustment and light weight. Other specialities are the "Driscol" high-frequency detachable transformer, duolateral tuning coils, low-frequency inter-valve and telephone transformers, and Dubilier combined leak and condenser. In "Tangent" broadcast receiving sets, Messrs. Gent and Co offer a 2-valve receiver and (1) and (2) note magnifiers, all of approved design and arranged for convenient combination where loud speakers are to be used in conjunction.

The London Electric Wire and Smiths, Ltd., have recently issued a new price list of their goods, including cables, flex, bell wires, telephone cords, armature and magnet wires, instrument wires, etc. It is a very well printed catalogue, and is neatly arranged in a special binding, which will permit of the addition of further pages as issued. It is, therefore, likely to be much appreciated by electrical engineers, installation contractors and others, to whom it will be sent on application, enclosing trade card. There is also an important section dealing with the technical terms associated with wires and cables, which is likely to prove of much interest to electricians generally.

The Sterling Telephone and Electric Co., Ltd., have just issued two new wireless publications, Nos. 347 and 348, describing their latest developments in broadcast receiving sets. For broadcast licensees they now offer sets made upon the "unit" system, comprising tuner, detector and amplifier units. These units can be purchased seriatim if desired, and combined to give increased facilities in accordance with the purchaser's means and ambitions. The various units are of neat design, metal cased and provided with facilities for coupling without wires. In addition, there is the new Sterling combined crystal and valve set and the Sterling two-valve set, each of these new designs being available in two alternative cabinets of the vertical and sloping type respectively, to suit all tastes. There are also listed Sterling radio headphones, handphones, and a new design loud speaker, accompanied by appropriate power amplifiers.

A new price list of *Ballsok Beads* has just been issued by **Lionel Robinson and Co.**, 3, Staple Inn, London, W.C.1. Copies may be obtained on application.

The exhibit of **Messrs. Aeradio, Ltd.**, Radio Works, Abbotsford Avenue, West Green, London, N.15, at the Ideal Home Exhibition, included a complete range of "Melbaphones." These instruments are broadcast receivers embodying artistic appearance with electrical efficiency. The range exhibited included single, 2- and 3-valve sets, the *piéce de resistance* being a 2-valve combination-de-luxe, which, at a very moderate price, includes batteries, valves, 'phones and aerial equipment. Messrs. Aeradio also showed a representative range of accessories of first-class make.

A folder from **Messrs. Marryat and Place**, 28, Hatton Garden, London, E.C.1, deals with Crystal Sets Nos. (1) and (2), and 2-Valve Receiving Sets for broadcasting, as well as headphones, valves and other accessories.

Pitman's spring list of the latest books published by them, as well as those to be issued very shortly, will be of interest to quite a number of the readers of this paper, because it includes many interesting works on wireless and other technical subjects We can therefore recommend prompt application for copies.

Obituary.—We regret to announce the death, on March 26, at Cavendish House, Wickenham Road, Brockley, S.E. 4, of Walter Henry Willcox, governing director of W. H. Willcox and Co., Ltd., Southwark Street, London, S.E. 1. The funeral took place at Nunhead Cemetery on Saturday, March 31, at 11.30 a.m.

A Dictionary of Engineering Free.—The Bennett College, of Sheffield, who are so well known in connection with their correspondence tuition classes, are making an announcement in their advertisement in our current issue which will appeal to an enormous circle of readers. They are issuing an illustrated dictionary of engineering, which will be published in twenty-four monthly parts, and any and every reader can have a free copy of each monthly part on payment of postage. Applications should be made to Dept. D. 11, as per advertisement on page iii.



Use Ashley Radio Products
ASHLEY WIRELESS TELEPHONE CO. LTD.
69 Renshaw Street Liverpool

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A POPULAR SCIENTIFIC WEEKLY JOURNAL
ELECTRICITY
A PRACTICAL TRADE JOURNAL

APRIL 13, 1923.

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THE WESTERN ELECTRIC PUBLIC ADDRESS SYSTEM.

A feature of considerable interest at the recent *Daily Mail* Ideal Home Exhibition was the amplifying and distributing of the band music throughout the whole of the Exhibition, as we have already mentioned, by means of the Western Electric Public Address System. The following details are of interest.

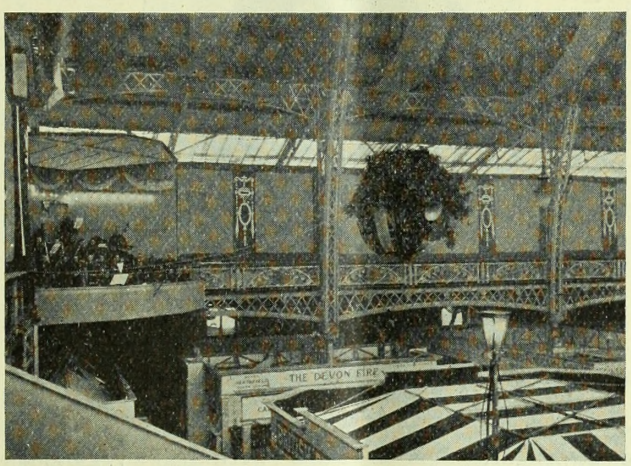


FIG. 1.—SHOWING THE BANDSTAND ON THE LEFT AND THE BOUQUET OF PROJECTORS ON THE RIGHT DRAPED WITH FLAGS AND DECORATED WITH EVERGREEN.

Alongside the bandstand in the north-west corner of the gallery was a small stand containing the control panels and electrical devices for distributing the sound telephonically to projectors placed in various positions throughout the exhibition. The Main Hall, for example, was served by four projectors noticeable above the band close to the bandstand (Fig. 1), which projected and directed the sound, and thus rendered the music of a uniform loudness in every corner of the hall. In the gardens a group of four projectors (Fig. 2) served the whole area, receiving their energy electrically from the same control mechanism as the others. Projectors were also to be noticed in the other positions already mentioned, e.g., in the New Hall gallery (see Fig. 3).

The complete equipment is under the control of an operator, and the degree of loudness from any one particular projector can be adjusted according to circumstances. To enable this to be accomplished to the best advantage, a system of telephones is arranged whereby a person listening in a remote corner can

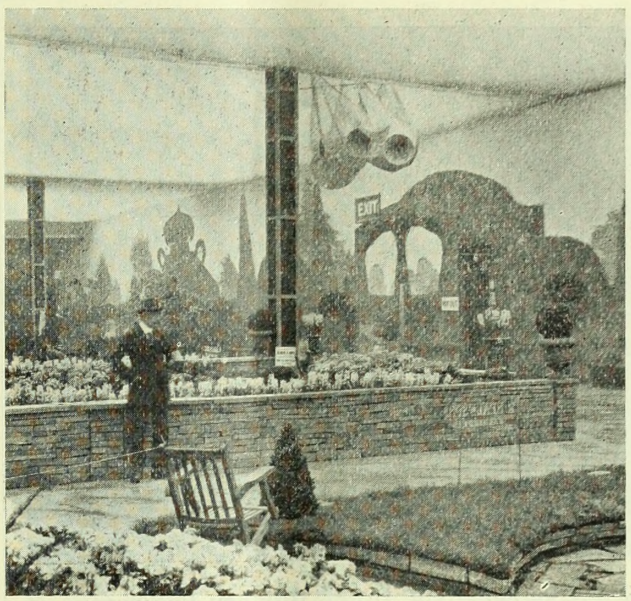


FIG. 2.—THE ROYAL GARDENS AT OLYMPIA, SHOWING A GROUP OF PROJECTORS COVERED WITH SKY-BLUE GAUZE.

communicate with the operator and arrange for the apparatus to be adjusted as desired. In this way it is possible to secure a natural effect, as any attempt to amplify the sound to an unnatural degree, as is often attempted, results in mere noise rather than music.

The system has been primarily designed to aid public speakers, and consists essentially of three distinct portions—the microphone (Fig. 4), which picks up the music or spoken word, the amplifier and the loud-speaking projectors, which throw the required volume of sound over the area to be covered.

The microphone is an exceedingly sensitive instrument, which forms the heart of the system. It is designed so that the natural period of vibration of the diaphragm is well above speech and music frequencies, so that resonance of the diaphragm at these frequencies is avoided, resulting in exceptionally pure reproduction of music or speech. The diaphragm actuates two microphone buttons connected in a special way in the input circuit so as to eliminate any distortion of the speech or music currents generated in the buttons by the vibration of the diaphragm. The microphone is sensitive to speech at distances from three to eight feet from it. It is even more sensitive to music, owing to the fact that music, whether singing, orchestral or bands, is generally louder than speaking, so that the microphone may be placed further away from the source of sound.

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The amplifier consists of four stages of amplification, the first two stages being voltage amplification, the third stage current amplification, and the final stage power amplification. The power valves in the final stage are connected in a special differential circuit to eliminate any chances of distortion. The amplifier is constructed in panels, the cabling from the microphones being brought on to one panel, which is provided with the means of switching to any desired microphone. It also contains telephone apparatus to enable the operator of the amplifier to get into touch with his observers.

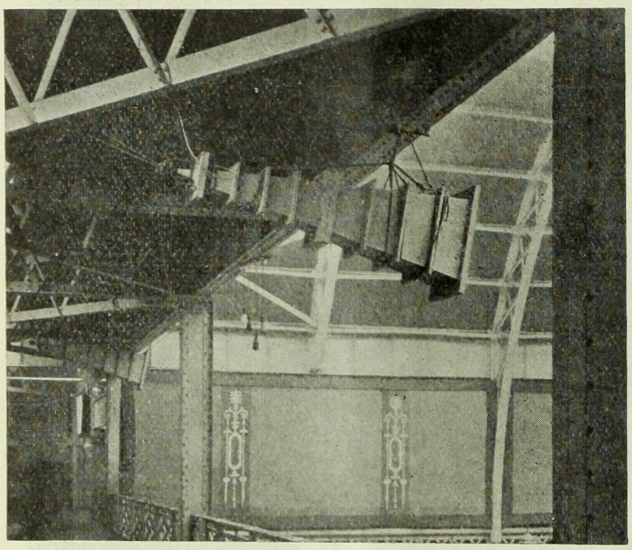


Fig. 3.—Showing the Large Wooden Projectors at the End of the Gallery in the New Hall, Olympia.

Another panel contains the apparatus associated with the first three stages of amplification—that is, two stages of voltage amplification and a stage of current amplification, as explained above. It is on this panel that the total output from the system is regulated, by means of a potentiometer situated between the first and second stages. An additional panel contains the necessary measuring instruments, and is provided with plugs and cords so that the current in any part of the system may be measured by plugging the plug into jacks provided on the amplifier panel for this purpose. The volume indicator has a valve detector device which measures the A.C. power in the system by means of a deflection on a galvanometer, and enables the proper transmission level of the system to be maintained. The power amplifier receives the output from the first amplifier and increases the power available to such a value as to operate the projectors at the required volume to cover the area served by the projectors.

Finally, there is a control panel provided for adjusting the volume in the individual projectors to the desired value. This also contains keys for cutting in or out of the circuit any desired projector, and a master key for switching out all projectors simultaneously.

The arrangement of the projectors for serving the Exhibition were as follows:—Four projectors for the Main Hall, these being suspended above and slightly forward of the orchestra. The two centre projectors were provided with medium-size wooden trumpets, the outer projectors being small fibre horns. The smaller horns were installed in these positions for the reason that the area they cover is not great enough to warrant the larger wooden trumpet. A single fibre horn serves the garden, and is mounted in the corner nearest the orchestra. The New Hall is covered by two fibre horns mounted in the centre at one end. A single projector with fibre horn serves the Pillar Hall. At the Hammersmith Road entrance, and also at the Addison Road entrance, a projector with a small curved horn was fitted, the total volume required in these cases being much less than in the main buildings.

The loud-speaking projectors operate upon the principle adopted by the Western Electric Co., Ltd., and used by them in their wireless loud-speaking equipments. They are of the balanced armature type, combining great sensitiveness with the ability to handle comparatively large voice currents without distortion.

The Public Address System can be used to enable an audience to hear either speech or music from some distant station by introducing a telephone line such as was recently used by H.R.H. the Duke of York when speaking from Buckingham Palace to the Agricultural Hall, or the speaker may face his audience with the microphone in position some few feet in front of him. In the latter case the loud-speaking projectors would be arranged overhead, or in such a manner as to produce uniform loudness of sound in any part of the area it is required to cover.

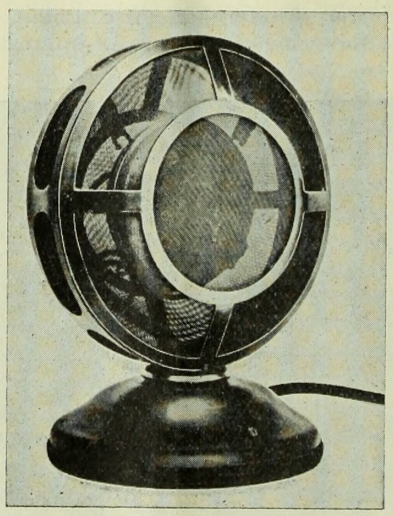


Fig. 4.—A Microphone Used with the Western Electric Public Address System.

The W. E. Co. recommend that two attendants should be present when the system is in operation, one stationed with the amplifying apparatus and the other in a distant part of the hall. These two attendants should be in telephonic communication, and in this way the instrument attendant can be instructed to adjust the mechanism in such a manner that perfect results are obtained.

Although very great amplification can be secured, it is usually not desirable, as it appears unnatural and displeasing, not due to distortion, but because the ear is not accustomed to so large a volume of speech.

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This is obvious if one considers the buzzing of a mosquito, which, if magnified to the loudness of a large steam hooter, would probably not be in the least suggestive of the familiar insect. It is the aim, therefore, to adjust the apparatus so that the volume at the required distance is equal to that of the normal voice weakened by an appreciable distance. Used under these conditions, the sound is heard perfectly normal, and in many instances people have been heard to remark that the apparatus is not working. As soon, however, as the apparatus has been switched off the difference has been most surprising.

With the correct functioning of the system, therefore, the ideal conditions are reached when the observer is not conscious of the use of the loud-speaking equipment, and has the impression that he hears the words of the speaker direct.

Without a doubt, the Public Address System, if it is as successful as the preliminary trials indicate, will be in great demand, and if it can be arranged in a portable form—mounted on a lorry, for instance—so that it may be available at any place and time, the most deterring feature associated with mass meetings will have been removed.

N.A.S.E. ENTERPRISE.

The board of control of the National Association of Supervising Electricians has decided to encourage the education work of the association still further by the annual award of prizes for papers by members on subjects connected with the electrical industry and/or the association.

In addition to three prizes, a trophy for the annual competition in the form of a *valuable silver shield* has been kindly presented by the president, Mr. W. E. Highfield, M.I.E.E., for the best paper of the year. Briefly, the arrangements are as follows:—

Papers to be read at a members' meeting on Tuesday, May 8.

Entries to be notified to the general secretary by April 12.

Papers to be of about 1,000 words and to be of ten minutes' duration.

Subject to be connected with the electrical industry or the N.A.S.E.

Awards to be made upon a ballot of the members at the meeting.

The winner of the first prize will be entitled to hold the shield for one year, and his name will be suitably inscribed thereon.

Certain rules will be decided upon at a meeting of full members on April 12. Provincial members are invited to compete, and members of the committee will be chosen to read the papers. Every effort will be made to ensure absolute impartiality in the judgment.

The object is to encourage papers of a practical nature and original thought, and these will receive first consideration in judging.

The literary excellence is of minor importance. We trust that members of the society have given every support to the B.O.C. in this new departure by entering for the competition in large numbers and will confirm it by their attendance at the meeting on May 8.

TELEGRAPHY.*

Being Solutions to the Questions set by the City and Guilds of London Institute at the Final Grade Examination in Telegraphy held in May, 1922.

Compiled by a Silver Medallist.

(*Continued from page* 183)

Q. 7.—Explain precisely the tests to which copper wire is subjected. What is the breaking stress of hard drawn copper wire weighing 200 lb. per mile?

A.—The finished wire from the manufacturers is made up into coils each consisting of about ½ to ¾ of a mile of wire. The wire constituting each coil must be drawn in one continuous length; it must be perfectly cylindrical, uniform in quality, pliable, free from scale, inequalities, flaws, welds, splits and other defects. To ensure that the coils are satisfactory in these respects the wire is tested for diameter by means of a micrometer and subjected to a careful visual examination.

Test pieces are selected and cut from the coils to enable tests to be made for ascertaining the mechanical and electrical properties of the wire.

The mechanical tests made are for determining the ductility and tensile strength (*i.e.*, breaking load). As a rule the following two tests are made for ductility:—

(*a*) The wire is wrapped in six turns round wire of its own diameter, unwrapped and again wrapped in six turns round wire of its own diameter in the same direction as the first wrapping. The test piece must withstand this test witnout splitting or breaking.

(*b*) The wire is gripped by two vices, one of which is made to revolve at a speed not exceeding one revolution per second. The twists thus given to the wire are reckoned by means of an ink mark which forms a spiral on the wire during torsion. The total number of twists, visible between the vices, that the wire should withstand without breaking depends upon its gauge. For example, a 200 lb. copper wire should be capable of withstanding not less than 20 twists in a length of 3 inches.

Tensile tests are carried out on an approved testing machine which provides means of stretching the wire with the object of finding its ultimate breaking load. For a 200 lb. copper wire the breaking load should not be less than 650 lb.

The efficiency of the wire as a conductor of electricity is determined by measuring the electrical resistance of test pieces by means of some form of Wheatstone Bridge. The test pieces for this purpose should not be less than $\frac{1}{30}$th of a mile in length. The maximum resistance per mile of each test piece thus measured, when reduced to the standard diameter of the wire and calculated for a temperature of 60° F., must not exceed a certain resistance depending on the gauge of the wire. For example, in the case of a 200 lb. copper wire, the standard diameter is 112 mils., and the resistance of a test piece measured by the Wheatstone Bridge, when reduced and calculated as specified above, must not exceed 4.3936 ohms per mile.

(*To be continued.*)

* Consult also "Questions and Solutions in Telegraphy and Telephony," Final Grade, by Few, 2s. 3d. post free from Electricity Office.

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ELECTRICAL ENGINEERING.—FINAL GRADE.

Solutions to 1922 Examination Questions of the City and Guilds Institute.

By Edward Hughes, B.Sc. (Eng.), A.M.I.E.E.

(*Continued from page 614, Vol. xxxvi.*)

Q. 13.—Compare a three-phase, four-wire distributing system with 400 volts between phases and 230 volts between phases and neutral, and a three-wire, 400-volt continuous-current distributing system as regards (*a*) weight of copper for the same power, (*b*) other conditions affecting the cost of distribution.

A. 13.—Suppose P to represent the total power to be transmitted, and $\cos\phi$ to be the power-factor of the A.C. supply. The two systems will be compared on the basis of equal efficiency of transmission, and therefore equal line losses.

For the 3-phase system, line current $= \dfrac{P}{\sqrt{3}\times 400\cos\phi}$

and ,, D.C. ,, ,, ,, $= \dfrac{P}{400}$

If A_1 be the area of each line for the three-phase system, and A_2 be that of each outer for the D.C. system, then for a given length of line—

resistance of each line for A.C. system $= \dfrac{k}{A_1}$

and ,, ,, ,, ,, D.C. ,, $= \dfrac{k}{A_2}$

where k is a constant.

Loss per line with A.C. system $= \left(\dfrac{P}{\sqrt{3}\times 400\cos\phi}\right)^2 \times \dfrac{k}{A_1}$

and ,, ,, D.C. ,, $= \left(\dfrac{P}{400}\right)^2 \times \dfrac{k}{A_2}$

But total line loss with A.C. system } = total line loss with D.C. system,

i.e., $3\left(\dfrac{P}{\sqrt{3}\times 400\cos\phi}\right)^2 \times \dfrac{k}{A_1} = 2\left(\dfrac{P}{400}\right)^2 \times \dfrac{k}{A_2}$

$$\therefore \frac{3}{3\cos^2\phi}\times\frac{1}{A_1} = \frac{1}{A_2}$$

$$\therefore \frac{A_2}{A_1} = \cos^2\phi.$$

It has been assumed that both the A.C and D.C. systems are balanced so that losses in the neutral wires can be neglected. If the neutral wire in each case be made half the cross-section of one of the corresponding outers, we have—

Total area of copper for the A.C. system $= 3.5A_1$

and ,, ,, ,, ,, D.C. ,, $= 2.5A_2$

$$\therefore \frac{\text{Weight of copper for A.C. system}}{\text{Weight of copper for D.C. system}} = \frac{3.5A_1}{2.5A_2}$$

$$= \frac{3.5}{2.5}\times\frac{1}{\cos^2\phi} = \frac{1.4}{\cos^2\phi}$$

Other conditions affecting the cost of distribution are :—

(*a*) For a given total cross-section of copper, the cost of a cable for a 3-phase, 4-wire system is greater than that for the 3-wire D.C. system.

(*b*) The insulation of the A.C. system has to withstand the peak voltage, namely, about 566 volts between the line conductors, whilst the maximum stress on the insulation of the 3-wire D.C. system is limited to 400 volts.

(*c*) Greater complication of the 4-wire system at junction boxes and other points where connections have to be made.

(*d*) Greater difficulty is experienced in balancing the load between the neutral and the three lines than in balancing the load on a 3-wire D.C. system.

Q. 14.—With six tramcars running equally spaced along a single track, the total return current along the rails is 300 amperes; the distance from the power station to the first tramcar is the same as the equal spaces between the tramcars. Work out for this condition the maximum resistance that the rails can have if the voltage drop in them is to be kept within the limit permitted by the Board of Trade regulations, and what power will be lost in this resistance.

A. 14.—If the cars be assumed to take equal power, the currents in the various rail sections, starting from the generating station, will be 300, 250, 200, 150, 100 and 50 respectively. Let r be the resistance of rails between any two adjacent cars, then—

Total voltage drop $= r\,(300+250+200+150+100+50)$
$= 1{,}050r$

But this pressure drop must not exceed 7 volts; consequently the maximum resistance that the rails can have is given by—

$$1{,}050r = 7$$

$$\therefore\ r = \frac{7}{1{,}050} = 0.00667 \text{ ohm},$$

and total resistance of the rails from the generating station to the sixth tramcar $= 6\times 0.00667 = 0.04$ ohm.

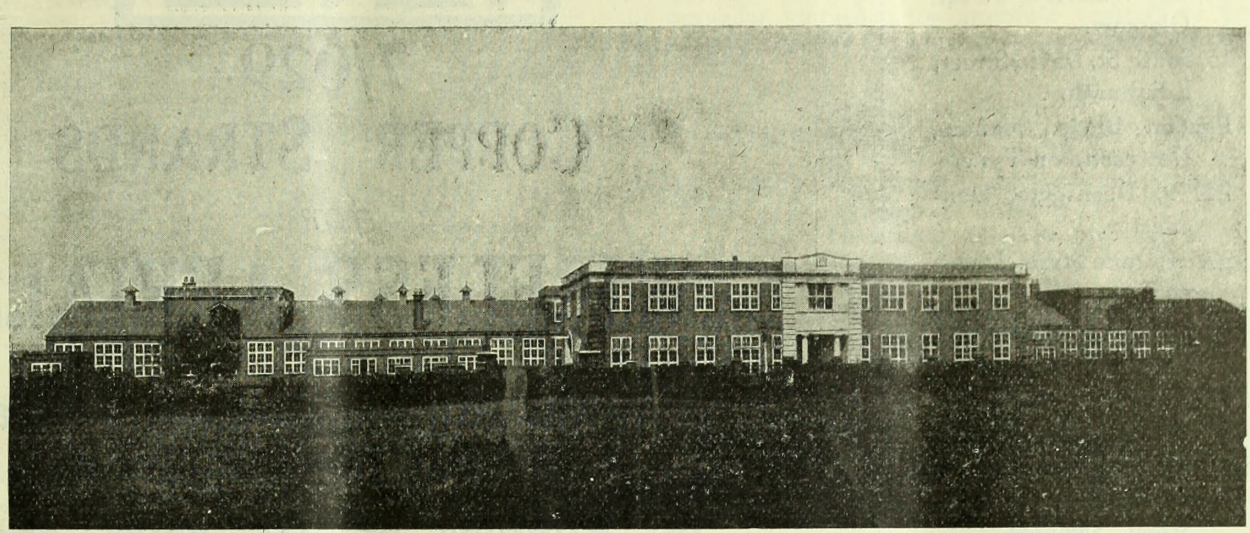
Total power lost in this length of rails
$= 0.00667\{300^2+250^2+200^2+150^2+100^2+50^2\}$
$= 1{,}517$ watts.
$= 1.517$ kW.

(To be continued.)

"The Home of 1923."—Electrical, of course. A valuable addition to the E.D.A. series of educative literature is a 16-pp. booklet recently produced by the **British Electrical Development Association, Inc.** (15, Savoy Street, Strand, W.C. 2), and having an attractive and arresting cover in two colours. The letterpress, fully and suitably illustrated, deals concisely with the use of electricity for all purposes in the home, and urges prospective consumers to "use electricity in your homes and you will have light, heat, and help laid on." A new E.D.A. poster is also available to advertise the same theme. It has a large buff panel, in which electricity suppliers, etc., can have printed any letterpress matter they desire. Both items are well worth being made extended use of.

No. 1 of the *Benjamin Bulletin* has just come to hand. It is the start of a series which will be published regularly by our old friends, the **Benjamin Electric, Ltd.**, at Brantwood Works, Tariff Road, London, N.17, and is sure to interest a large number of the customers of this well-known company. This issue deals with automobile matters in general and Benjamin Automobile Products in particular, for instance, the electric horn, reflectors for car lamps, garage equipment, etc. It is a well-printed pamphlet, and should be asked for without delay by all contractors and garage owners.

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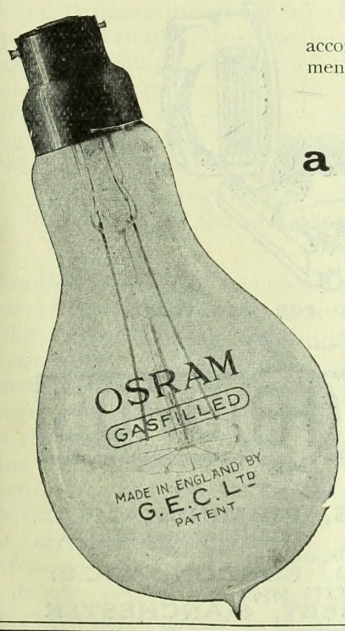
A TALK WITH THE RE-SELLER.

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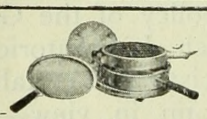
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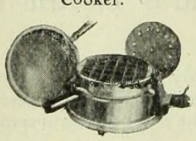
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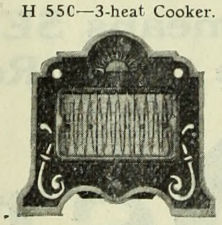
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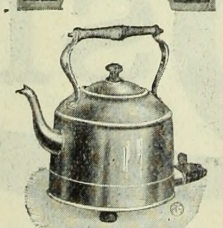
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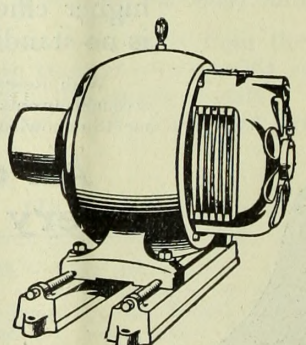
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TO OUR READERS.

Electricity is published every Friday, and, if ordered, is on sale at the principal Railway Station Bookstalls and Newsagents on that day. It has a very large sale throughout the United Kingdom, as well as in the British Colonies and Abroad.

New advertisements for the displayed columns and alterations to existing ones must reach the publishing office not later than first post Tuesday morning, in order to be in time for the issue of the following Friday. This is important. Rate quoted on application. Subscription: 13s. a year, 6s. 6d. half year, 3s. 3d. a quarter in advance, postage prepaid in the United Kingdom and abroad.

Questions to which an answer is required must be accompanied by a 1½d. stamp for reply. When considered of sufficient interest, the answer will probably appear in the paper.

All remittances payable to the Publishers, S. Rentell and Co., Ltd., 36-39, Maiden Lane, London, W.C.2. Telephone No. 2460 Gerrard.

Current Topics.

Electricity as a Curative.

With advancing knowledge of the possibilities of electro-therapeutics, there is every possibility of some of the more stubborn diseases to which humanity is subject yielding to electrical treatment. One of the latest applications of electricity to prolong life and reduce suffering is in connection with pneumonia, one of the diseases to which residents of these damp, foggy isles so often succumb. The treatment, known as diathermy, has been successfully applied in St. Mary's Hospital, Hoboken, U.S.A., and has been successful in twenty cases treated at the United States Marine Hospital on Staten Island. Pneumonia involves a congested condition of the lungs and air passages with accompanying difficulty in breathing and consequent poisoning of the circulatory system, due to the fact that the lungs are unable to function normally for the regular purification of the blood.

The diathermic treatment is applied by way of metal plates in contact with the chest and back of the patient, and the principle consists in passing a sufficient current through the lung tissues from back to front to increase the internal temperature of the tissues sufficiently to break down or melt the congestion substances. Diathermic treatment is really a more modern and thorough adaptation of the older remedies such as mustard plasters and the like, or the more modern thermogene treatment, all of which aim at raising the internal temperature of the affected tissues of the body. Applied externally, these palliatives are only partially successful because the trouble in such cases is deep seated and surface application of heat does not penetrate sufficiently to reach the affected layers. Diathermy ensures a thorough heating of the whole mass of tissue on the principle of electrical resistance heating, and, moreover, is regulatable according to the capacity or requirements of the individual patient.

Another electrical treatment which will appeal to those overburdened with adipose tissue was exhibited at the recent Nursing Exhibition at the Central Hall, Westminster. It is the British Red Cross Society's treatment for obesity, and is claimed to reduce fat by making the muscles work. An intermittent current is sent through the body as the patient reclines in a metal chair, with parts of the body in contact with metal electrodes. The current stimulates the muscles to a remarkable degree, and surplus fat is said to disappear at a corresponding rate. It is a well known fact that hard work or considerable physical exertion will reduce fat people, hence the general principle of taking as much vigorous exercise as possible on the part of those who suffer from an excess of adipose tissue. Apparently the electrical treatment achieves the same result, but without voluntary effort on the patient's part, by setting up muscular vibrations of alternate contraction and elongation under the stimulus of the interrupted current.

Light Without Heat.

With the economic combination of incandescent metal filament surrounded by an inert gas as exemplified in the modern gasfilled electric bulb, we are rather apt to regard the limit in economical illumination as having been finally reached, but there is still a further stage of development, and if report speaks truly we are on the eve of another revolutionary achievement in artificial lighting, calculated to reduce the purely lighting load of most power stations to really negligible proportions. For centuries scientists have laboured at the problem of dissociating light from heat, the two having hitherto been regarded as inevitably associated in our mundane scheme of things. The glow-worm, with its weird phosphorescent glow, has long been pointed out as Nature's solution of this apparently insoluble problem, and now a French scientist, M. Risler, formerly head of the Strasburg University Laboratory, claims to have reproduced the performance of this interesting insect by producing light electrically without any accompanying heat.

Although full details are lacking at the time of writing, I understand that M. Risler utilises tubes or bulbs filled with a special gas, under a certain pressure. The tubes or bulbs are coated externally with a phosphorescent mixture having sulphide of zinc as a base, a well-known fluorescent substance. When an electric current is passed through these tubes they emit a quantity of illumination stated to be incomparably superior to that from ordinary sources. For example, a tube, six yards long, although consuming electrical energy costing less than one-eighth of a penny per hour, will furnish some 200 c.p. The combination necessary to these results is stated to be extremely simple, an alternating current being employed. The inventor's estimate of the current consumption is fifteen watts for six metres of tube having a diameter of seven millimetres. Moreover, by varying the character of the gas inside the tube the resultant colour of the light can be changed at will, violet, green, yellow or white light being produced according to the changes affected at a demonstration given in Paris. I shall await further details of this most interesting discovery with keen interest.

Bad Wiring—A Chance for the Unions.

According to reports considered by the Hull Corporation Electricity Committee there is a vast amount of bad and careless workmanship in wiring and installation work up and down the country since 1919, a fact which is attributed to the considerable influx of untrained and inexperienced men into the wiring trade since the war. The trouble has been considerable in Hull, but is stated to extend to other towns where these men have been active in securing wiring business at prohibitive cut-throat rates. Now I have always contended that one of the legitimate functions of a trades union is to maintain the quality of the work carried out by its members, and here, it would appear, is an excellent opportunity for the E.T.U. to justify its existence by investigating the

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capabilities of its large membership and making competence an essential qualification for entry into its ranks.

As one member present at the Hull discussion remarked, 25 per cent. of the electrical installation work in Hull to-day is being done by a class of men who, because they could not get a job, were going about offering to undertake wiring at prices which barely covered the cost of the necessary materials. The only way to put a stop to this sort of thing was to insist that no one should be allowed to do electrical work unless he was a qualified electrician. The chairman remarked that some people think if you want to put a few wires in a butcher's shop, all the kit you require is an American screw-driver, a pair of pliers and a big fat hammer.

With Labour as independent as it has been since the war it is impossible for the Electrical Contractors' Association to control effectively the quality of the work turned out by employees of its members. This is more truly a function of the trades union, and if the latter body acted up to the sounder principles of unionism and saw to it that only competent men were admitted to unionism there would be a very much stronger argument in favour of employing only union labour. As matters stand, almost anyone can join a union for the price of a membership ticket, and his efficiency is not called into question. If the unions went to the employers' association with the slogan : "Our members are all proved and competent men at their trade." instead of bestowing all their worship on the minimum wage fetish, they would have an infinitely stronger appeal and would be in a better position to control the all-important wage factor than they can ever hope to be under the present conditions of unionism.

Elektron

BRITISH EMPIRE EXHIBITION (1924).

We have just received from the British Engineers' Association a ground plan showing the progress of space-letting in their Shipbuilding, Marine, Mechanical and General Engineering Section of the British Empire Exhibition, covering an area of 217,000 sq. ft., in the Machinery Hall.

It shows in a striking manner the remarkable progress already achieved in the sale of stand space, with the result that the organisation of the Engineering Section is already so far advanced that success may be regarded as assured.

The space plan is accompanied by a schedule giving the dimensions, frontages and prices of the stand spaces still available when the plan was printed.

It is quite clear that eligible firms who have not yet booked space would be well advised to make up their minds and send in their applications without further delay, as the limited number of stand positions still available will be allotted on the basis of priority of application. Copies of the plan and schedule and any other information required can be obtained from the British Engineers' Association, 32, Victoria Street, London, S.W.1.

Plant for Sale.—An advertiser has for sale a 60-h.p. gas engine complete with gas producer and dynamo. For particulars see small advertisement.

Questions and Answers by Practical Men.

RULES.

Questions: *We invite our readers to send us questions, preferably on technical problems that have arisen in actual practice. Questions which we consider of sufficient interest to our readers will either be replied to under "Answers to Correspondents" or replies will be invited from our readers. One shilling will be paid for the question which we select for competitive replies in this column.*

Answers: *A fee of 10s. will be paid for the answer which we consider shows the greatest merit, and 5s. for the one we select as second best. In judging the replies, importance will be attached to clearness and conciseness, as well as accuracy. The Editor reserves the right to make no award, or to accept only one reply, if, in his opinion, the answers received do not possess sufficient merit. Competitors desiring the return of their manuscripts, if unaccepted, should enclose stamped addressed envelope.*

Write on one side of the paper only, and if diagrams are sent, draw them on a separate sheet of paper attached to the manuscript. Competitors may adopt a "nom de plume," but, both in the case of questions and answers, the competitor's real name and address must be sent with the manuscript as a guarantee of good faith. No correspondence will be entered into with regard to successful replies. The Editor's decision is final.

Commencing with Question No. 101, a Diploma of Merit will be awarded to the six competitors who win the first or second prize the most times during the next twelve months.

The words "Questions and Answers" or "Q" and "A" should be placed at the top left-hand corner of all letters intended for this column.

Question No. 157.

Can any reader give me details from which I can make a Nodon Valve to enable me to charge accumulators from an A.C. supply? What is the action of such a valve?—"Wireless."

Question No. 158.

I have to repair a number of accumulators. My difficulty is that I do not know how to connect the bridge pieces, that is, the bars which are connected across the top of each set of plates. I understand that these are "burnt" on. How is this done?—"Accumulator."

(*Replies to Questions* 157 *and* 158 *must be received not later than April* 28, 1923.)

Answers to Questions.

Question No. 153.

Is the old Marconi coherer suitable for wireless telephony receiving sets? If so, how can I adapt it for this purpose?—"B.B."

Replies to Question No. 153.

Note.—Although several replies were sent in to this question, no competitor could say that the old Marconi coherer was suitable for use in the modern wireless telephony sets. The old Marconi coherer was merely a make and break device used to actuate a relay in the tapping circuit. The "tapper," in addition to indicating a dot and dash, decohered the nickel filings in the tube, and so the circuit was interrupted until the next wave came along. Since the crystal detector came into being, the manufacture of coherers has been stopped. The only thing "B. B." can do now with his old coherer is to place it on one side. Probably in years to come the coherer may be looked on as a curio and the first step towards the possibility of the enormous broadcasting stations, which are sure to be erected in due course.—Editor, Electricity.

A Prize Worth Winning.—The Rand Mutual Assurance Co., Ltd., Johannesburg, Transvaal, offers prize money not exceeding £250 for design or designs of the most practicable device for recording shaft signals in the mines. Entrance is free and open to all, including mercantile firms. Entries close September 30, 1923. Copies of conditions of the competition may be obtained from J. F. Bilbrough, Managing Secretary, the Rand Mutual Assurance Co., Ltd., Third Floor, Chamber of Mines Building, C.R., Main and Holland Streets, or P.O. Box 413, Johannesburg, Transvaal, South Africa. This should appeal to the very large number of our readers who are interested in mine signalling apparatus.

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SOME TRAIN LIGHTING SYSTEMS.*

By Cyril T. Cocks.

(*Concluded from page 182.*)

Excellent regulation is obtained by the double battery (Fig. 4), and it is important to note that this is inherent in the working principle and is not dependent on the continued perfect adjustment of any regulating mechanism. This is an important factor in the economy of lamp renewals. While on the subject of double batteries, it is interesting to note that little or no saving is effected by the use of the single battery, while the advantages gained by the use of the double battery will be made patent by considering the following points:—

(1) Individual cells are half the weight and easier to handle.
(2) Better distribution of weight and more easily accommodated.
(3) There is a complete duplication of the battery and its connections, thereby minimising any chance of failure to lamps.
(4) There is a perfect regulation of the voltage owing to one battery always "floating" on the lamps, ensuring steady light and increasing the life of the lamps.

Relating to control gear, all Stone's machines in use on these railways come under three headings:—

(1) The Gill type machine.
(2) The Gill machine with Liliput conversion.
(3) The Liliput machine.

As far as practicable, all mechanical controls are being gradually eliminated.

In connection with the double battery system it has been explained that during lighting periods one battery only is being charged, while the other floats across the lamps. It, therefore, follows that during a long lighting run the batteries get into an unbalanced state.

Fig. 5 shows diagrammatically the Stone's Pegoud Battery change-over switch designed by the makers to overcome this. As is seen in the diagram, the function of this switch is to change over the batteries every time the train restarts after a stop, so that if "A" battery was receiving a charge and "B" battery was floating, their positions would be reversed during the next period of the run, thus ensuring both batteries being evenly charged, and further improving the regulation of voltage to lamps.

The Pegoud switch consists essentially of a shunt wound solenoid, to the core of which is attached a spring pawl which operates a ratchet, to which is coupled a revolving two-segment commutator, which in turn alters the relative position of the batteries every time the current is interrupted, the core dropping by gravity.

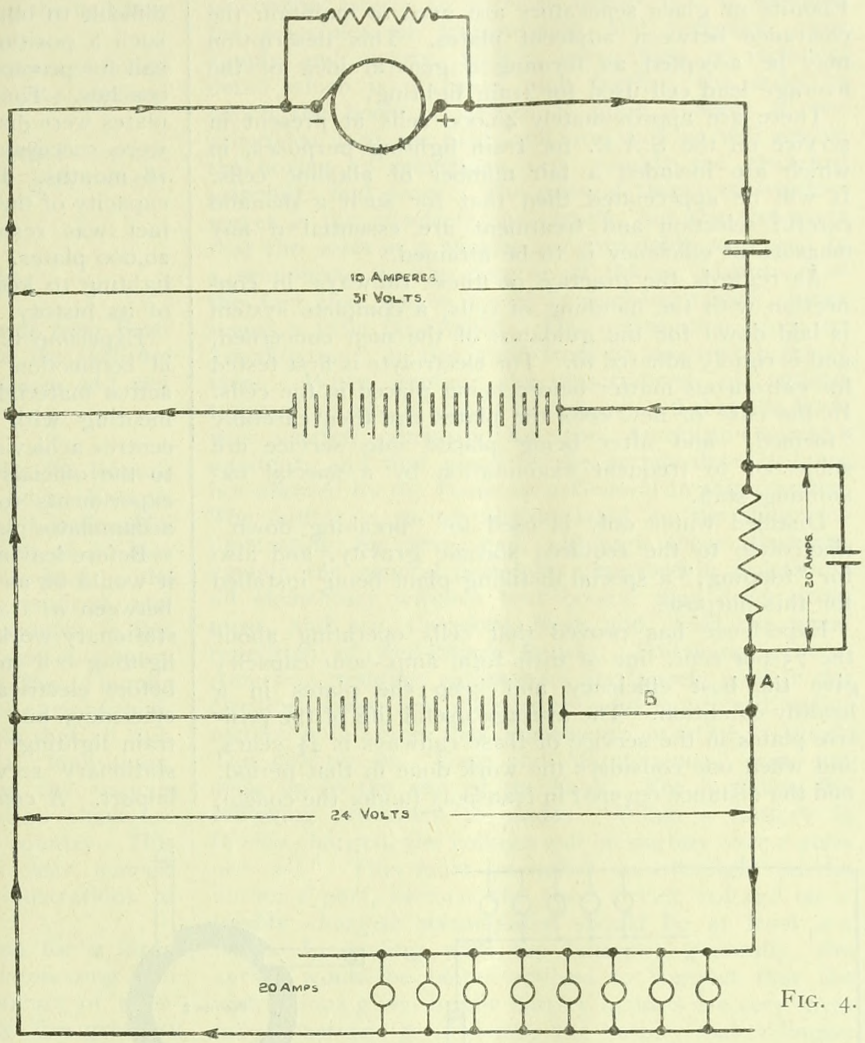


Fig. 4.

Diagram of Regulation Balance.

The installation of the Pegoud switch has effected a saving in battery power and a big increase in efficiency.

Accumulators.

Accumulators form the key to successful train lighting, and are common to almost all systems. It has been said that if the accumulators are well cared for the rest of the system takes care of itself: rather a risky statement to make, but it serves to mark the importance of this branch of any system. The history and theory of the storage battery is too well known to need repetition in this paper. It will be appreciated, however, that a train-lighting cell calls for special design in the matter of mechanical strength, both as regards the plates themselves and the cell boxes.

The cell box is usually made of hard wood and completely lined inside with sheet lead. A close fitting lid is used to prevent electrolyte splashing over when in service. The positive and negative lugs are passed through insulating gaskets fitted into the lid, while the latter should also contain conveniences for easily

* Abstracted from the *Transactions of the South African Institute of Electrical Engineers.*

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taking temperature for ventilation and testing gravity of electrolyte. The plates are insulated from the lead lining by a good grid, on which the plates rest. Ebonite or glass separators are used to maintain the clearance between adjacent plates. This description may be accepted as forming a general idea of the average lead cell used for train lighting.

There are approximately 40,000 cells at present in service on the S.A.R. for train lighting purposes, in which are included a fair number of alkaline cells. It will be appreciated then that for such a demand careful selection and treatment are essential if any measure of efficiency is to be attained.

As regards the practice on these railways in connection with the handling of cells, a complete system is laid down for the guidance of the men concerned, and is rigidly adhered to. The electrolyte is first tested for extraneous matter before being placed in the cells. In the case of new cells the plates are then carefully "formed," and after being placed into service are subjected to frequent examination by a special examining staff.

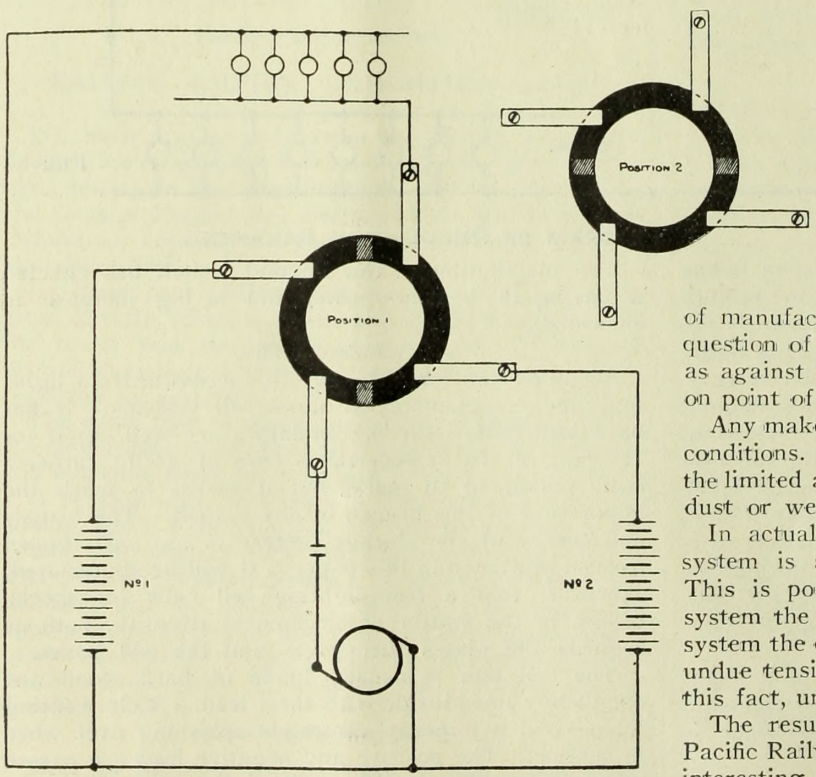
Distilled water only is used for "breaking down" electrolyte to the required specific gravity, and also for "topping," a special distilling plant being installed for this purpose.

Experience has proved that cells operating about the 75 per cent. line of their total amp.-hour capacity give the best efficiency and keep the plates in a healthy condition. The average useful life of the positive plates in the service of these railways is 4½ years, and when one considers the work done in that period, and the distance covered in transport (under the coach), this performance reflects very creditably on the organisation that has established such efficiency.

During the war period, when supplies were so difficult to obtain, the railway officials were placed in such a position as regards accumulator spares as to call for prompt action or else do without lights in the coaches. The possibilities of reframing the positive plates were discussed, with the result that 17,000 plates were successfully reframed with an average life of 18 months. It was further agreed to reduce the capacity of the cells from 145 amp.-hours to 110. This fact was responsible for the recovery of a further 20,000 plates. It was thereby made possible for train lighting to keep going during the most trying period of its history.

Experiments were carried out in the Capetown shops in connection with the repasting of old plates with active material, while ambitious Pretoria was experimenting with the manufacture of new plates, both centres achieving excellent results. Great credit is due to the officials concerned for their initiative, as these experiments formed the birth of the manufacture of accumulator plates in this country (South Africa).

Before leaving the subject of accumulators, however, it would be as well to mark the outstanding difference between a train-lighting cell and a cell used for stationary work, the difference being that for the train-lighting cell mechanical strength must be considered before electrical efficiency. A cell of high electrical efficiency, but mechanically weak, is of little use for train lighting purposes, while for certain station or stationary service electrical efficiency is of greater import. A combination of the two is, of course, the ideal to be aimed at. In a good make of plate, after four years' running the plate starts casting its active material, and there is but little loss in efficiency, as the plate itself has now become "plate-formed," and should be good for another two years.



Pegoud Battery Change Over Switch.

Fig. 5.

Belting.

It is very difficult to make a definite statement regarding the best type of belt for train lighting purposes, as one is always up against the inconsistency of manufacture in most types. Then, of course, the question of belt consumption in a slipping-belt system as against a non-slipping system has to be considered on point of fact.

Any make of belt is working under the worst possible conditions. First, there is the short drive. Secondly, the limited arc of contact. Thirdly, no protection from dust or weather.

In actual practice the belt wear on a belt-slipping system is slightly less than a non-slipping system. This is possibly due to the fact that in a slipping system the slip is recognised, while in a non-slipping system the extra precautions taken to prevent slip place undue tension on the belt, which still slips in spite of this fact, under varying conditions.

The results of some tests taken on the Canadian Pacific Railway during the winter of 1916 are somewhat interesting.

A copper-stitched Balata belt was removed after doing a train mileage of 102,150 miles on a slipping belt

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system, while a copper riveted Belata belt did 103,208 miles on the same system, the same class of belt doing 70,000 miles on a variable speed machine, while a hemp stitched belt completed 71,730 miles, when the belt was lost before the test was completed.

On the S.A.R. the best results have been obtained from the rubber-impregnated belt, which has attained a train mileage of well over 80,000.

The type of belt joint used on the S.A.R. is the surface Butt joint, and if cut squarely gives every satisfaction.

Reviews of Books, &c.

[Books noticed in this column will be sent from Electricity *Office to any part of the world, for the published price, plus ten per cent. for postage (minimum 2d.) and orders will be appreciated.]*

Railway Signalling: Automatic. By F. Raynar Wilson. 116 pp. 75 Figs. (Pitman, 2s. 6d.). Excepting railway signal engineers themselves, it is doubtful whether railwaymen in general have much of an idea of the requirements of signalling as determined by the speed and weight of trains, headway required, etc. But with the general speeding up, the tendency in this country to run longer trains than has been customary hitherto, and the necessity of reducing the "human element" to a minimum from the point of view of minimising the chance of error, it is desirable that all railwaymen should know the capabilities, limitations, reliability factor, relative cost, etc., of the various systems—manual, track circuit, automatic—which are in use or proposed in this or some other country. This little volume gives the information in a clear, concise manner, well aided by diagrams and illustrations of actual apparatus.

Railways always possess a fascination for a large class of men—young and old—as an interesting and instructive hobby. To such the beginnings of automatic signalling in this country are of the greatest interest; they see new types of signals constantly springing up, while with the electrification of railways entirely new systems appear. Anyone who takes interest in the subject will find this book of absorbing interest.

How to Form a Company. By H. W. Jordan. 104 pp. (Jordan, 1s. 6d.)—The well-merited success enjoyed by this publication is clearly indicated by the fact that the edition under review is the fifteenth, the first having appeared in 1913. As was the case with the earlier editions, the book indicates briefly, but clearly and sufficiently, the advantages that Incorporation under the Companies Acts affords and explains the machinery by which Incorporation is effected. Chief place is given to public companies, but the distinction between such and private companies is shown and the privileges attaching to the latter are set out. Anyone in business in a small way would do well to obtain a copy, while many connected with large businesses could read it with advantage. Companies are safer than partnerships, as is, or ought to be, known, and after all the formalities to be gone through are not very terrible.

Wireless Telephony For All. By Laurence M. Cockaday. (Herbert Jenkins, Ltd. 5s. net.).—This book marks another step in wireless literature, as it is confined solely to wireless telephony. It explains the principles of transmission and reception very simply and clearly, with a correctness of technical detail which is of value, and, further, the order in which the book is written is good. Some of the analogies used are new, and are such as will enable the novice to remember very readily the electrical principles laid down. The general theory of wireless waves is put concisely and clearly, but the statement that the seats in a theatre are invariably arranged in a semi-circle for the purpose of taking advantage of the fact that waves travel in ever-increasing circles seems a little far-fetched. The information given on "modulation" is also good from an amateur point of view. When reading the descriptions of various types of aerials, it should be remembered that the book was written primarily for the American wireless amateur, and that many of the aerials described are not allowed by the Postmaster-General in this country. The author is to be congratulated on the diagrams illustrating the text, and, although these diagrams explain the general principles described in practically all elementary wireless text books, they differ from most, and are, therefore, fresh and avoid the usual repetition of well-known figures. Following general American practice, variometers are largely used in the circuits shown, and all persons who have used variometers will agree that variometer practice is good. The chapter on "Care and Maintenance" does not come up to the rest of the book. For instance, the following statement is made: "When a battery is freshly charged, the voltage will be slightly over 2 volts per cell." This must be rather an oversight on the author's part, because the open circuit voltage on a freshly charged accumulator should be at least 2.5 volts. In dealing with the batteries generally, the author would be better advised to suggest that the instructions given by the battery makers are very carefully observed, as obviously the battery maker knows best how his battery should be treated. One of the most useful sentences the book contains, and one which will bear the strongest of emphasis, is: "Do not make the mistake of trying to get the signals in the loudest possible." This is wise and sound advice. Clearness should never be sacrificed for noise. The suggestion that telephones may be demagnetised by being dropped on the floor is certainly possible, but rather improbable. The information given on testing out an amplifying transformer is also somewhat misleading. A statement is made: "If no clicks are heard, one of the windings of the transformer is open." Even supposing a transformer winding is open circuited, it is very often quite possible to hear clicks in the circuit when testing in the manner described, as the capacity between the broken ends may be enough to produce a click in the telephone. The author is a humorist, or else has fully developed the gentle art of "leg-pulling." We refer to the story of the captain, who nearly cut the lightship in half, and to the following, which is one of his closing remarks: "Learn to operate your set before you pronounce it 'no good.' Invite some friend, or some friend's child, who does

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understand wireless, etc. To summarise the book as a popular exposition of wireless telephony, it is good, and can be read with interest by amateurs and enthusiasts.

Various Items.

Fire Extinguishers.—An advertiser has for sale a certain quantity of filled fire extinguishers which he wishes to dispose of cheap. See small advertisements page.

Argentine Customs Tariff.—We have received from the Department of Overseas Trade, 35, Old Queen St., London, S.W. 1, a pamphlet on the Argentine Customs Tariff, containing extracts from the laws and regulations which are likely to appeal to and assist all firms having commercial relations with the Argentine Republic. We can most certainly recommend it to electrical firms who export to Buenos Aires, etc.

E.C.A. Dinner.—The Secretary of the Electrical Contractors' Association wishes us to say with regard to the many applications he is receiving for tickets for the forthcoming annual dinner, April 24, that these are only supplied to members of the Association for themselves and their friends. It is suggested, therefore, that those gentlemen who wish to be present should get in touch with a member of the E.C.A.

Personal.—Mr. F. Charles Raphael, M.I.E.E., who, it will be remembered, severed his connection with the Edison Swan Electric Co., Ltd., last September, is now carrying on his consulting practice at his new office, St. Paul's Chambers, 19, Ludgate Hill, E.C. 4 (telephone Central 3387). He informs us that he would be very pleased to receive catalogues at the above address, particularly from manufacturers of electric-light fittings and accessories, electric domestic appliances, cables, testing instruments, wireless instruments and material. We trust that advertisers will avail themselves of this without delay.

Fuel Consumption, etc., Returns.—The Electricity Commissioners have just issued a 12-pp. foolscap pamphlet containing the analyses and summaries of the returns of fuel consumption and units generated, made to the Electricity Commissioners by authorised undertakers under the provisions of Section 27 of the Electricity (Supply) Act, 1919, and of the returns furnished by railway and tramway authorities and by certain non-statutory undertakings. The information given is certain to prove of direct interest to quite a large number of engineers, and they are informed that copies may be obtained on application to the Secretary of the Electricity Commissioners at Gwydyr House, Whitehall, London, S.W. 1, price 1s. net post free.

"**The Proof of the Pudding . . .**"—We have received from the General Electric Co., Ltd., a copy of leaflet No. B.C. 2,940, which, in addition to a description and illustration in colour of the Gecophone two-valve cabinet listening-in set, contains a selection of unsolicited testimonials from satisfied customers showing that from both Ayreshire and Aberystwyth music broadcast from New York has been received, and 2LO seems to be picked up in any part of Scotland by this two-valve set. Copies of the leaflet can be had on application to Magnet House, Kingsway, or from any of the company's numerous branches, and Gecophone dealers should find it a first-class selling line.

"**Standard Lighting.**"—This is the title of a new American book which has just been published. It deals directly with up-to-date illumination, and contains seventeen chapters, which have been written by seventeen of the leading illuminating engineers of the United States. Every phase of lighting and illumination is treated in this most practical and up-to-the-minute book. It is the acknowledged standard work on the subject, and is solving the lighting problems for the central stations, architects, engineers, contractors, and the installers of lighting fixtures throughout that great country. It contains 272 pages and 240 illustrations, and is well bound in a leatherette cover. The price is 15s. 6d. net post free from Electricity Office.

Wanted.—An advertiser wants to buy one or two D.C. sets, about 100 kw. or 50 kw. See Prepaid advts.

East Midlands.—The Electricity Commissioners have decided to confirm the area of the East Midlands Electricity District, subject to certain minor adjustments. A draft order to that effect will therefore be prepared, and a further local inquiry will be held at a date to be fixed later.

Meetings.—The next meeting of the Birmingham and District Electric Club will be held on Saturday, the 14th inst., at the Grand Hotel at 7 o'clock. Paper, "Engines for Small Electric Generating Plants," by Mr. E. Caudwell, A.M.I.E.E.——The Junior Inst. of Engineers will meet at 39, Victoria St., S.W. 1, on Friday, the 13th inst. Paper, "The Instrument Equipment of Aeroplanes," by C. B. Clapham, B.Sc. (Member). Slides and exhibits. Also on the 20th inst., Lecturette, "The Business of Engineering," by H. N. Munro (Member); and on the 27th inst., Lecturette, "Stock Control," by J. Fearn (Member). All at 7.30 p.m.——The next informal meeting of the I.E.E. will be held on Monday, the 23rd inst., at 7 p.m. Discussion on "Practical Broadcasting," to be opened by E. H. Shaughnessy. ——The I.E.E. will meet on Thursday, the 26th inst., at six p.m. Paper: "The Drive of Power-station Auxiliaries," by L. Breach and H. Midgley.

Trade Notes.

A selection of Simplex weatherproof and watertight lanterns, cargo cluster lights, steel reflectors, semi-indirect and bulkhead fittings, and a comprehensive range of lantern accessories and components is contained in a new list (No. 961) issued by **Simplex Conduits, Ltd.** (Garrison Lane, Birmingham). It need scarcely be pointed out that all patterns have been designed with a view to obtaining full benefit from the economy effected by the use of modern gasfilled lamps, whilst at the same time allowing ample provision for ventilation. The majority of the fittings have special deep tops, which can be supplied fitted complete with the new pattern anti-vibrator device. Attention has been given to the question of packing for export in the general design, so that numbers of the fittings can be nested into a small space.

A very businesslike mailing card has just been issued by the **Automatic and Electric Furnaces, Ltd.**, of 175, Farringdon Road, London, E.C. 1. It sets forth in brief terms the advantage of witnessing an actual demonstration of what can be done in the way of perfect hardening of carbon steel by means of the patent furnaces for which the company have built up such a reputation, and we hope that the results of the card will be to bring in a steady influx of interested clients.

"Prescot Jointing Compounds" is the title of a 4-pp. leaflet which has just been issued by the **British Insulated and Helsby Cable Co., Ltd.**, of Prescot. It describes the standard box compound as manufactured by the company under various grades for different uses and climates, and will therefore interest central-station and motor engineers, as well as electrical installation contractors generally.

A 4-pp. foolscap list has just been issued by **Brittain's Electric Motor Co.**, of 110, Cannon Street, London, E.C. 4. It gives a clear description of the qualities claimed for the new types of A.C. motors which the company are now putting on the market, as well as a list of the towns in which motors of the company's make have been working during the last thirty years. There is also an excellent list of testimonials affording practical proof that the motors do that which the makers claim for them.

Our old friends **Mosses and Mitchell**, of 122-4, Golden Lane, London, E.C. 1, are putting on the market a new line in the shape of the "Vandec" waste basket, for which they claim such lasting qualities that they are able to supply them under a five-year guarantee. They are made of vulcanised fibre, are absolutely non-inflammable, and these good points, together with their neat appearance, durability and cleanliness, should help to make this new line a very good selling proposition. We hope that Messrs. Mosses and Mitchell will obtain ample reward for their enterprise.

Use Ashley Radio Products
ASHLEY WIRELESS TELEPHONE CO. LTD.
69 Renshaw Street Liverpool

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A POPULAR SCIENTIFIC WEEKLY JOURNAL
ELECTRICITY
A PRACTICAL TRADE JOURNAL

APRIL 20, 1923.

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USE OF STATIC CONDENSERS FOR POWER FACTOR IMPROVEMENT.

The question of power factor, says M. R. Varret in a recent issue of the *Revue Générale de l'Electricité*, is as old as the practical applications of alternating current itself. For years past every producer of alternating current energy has suffered from the evil effects of low power factor, and has burned tons of coal per day simply to heat up the conductors of the network without advantage to anyone—indeed, with actual disadvantage, because the cost of the energy thus wasted has to be recovered by a higher charge for the effective energy sold to consumers, and the presence of the wattless current makes it impossible to generate and distribute as much useful current as could otherwise be done.

Conditions have been rendered appreciably worse by the fact that many large motors—of more or less good power factor at full load—installed during the war for munition service are still in service, but now at reduced output and therefore at very low power factor. Indeed, according to the author, certain installations are operating at a power factor as low as 0.15, so that the current circulating is nearly seven times heavier than it would be if the same effective power were supplied at unity power factor.

Human nature being what it is, about the only way to remedy this state of affairs is to charge more per unit for energy supplied to consumers who operate their equipment at low power factor. If ϕ be the phase angle between the current and voltage, the record of an ordinary supply meter is proportional to the product of the three quantities voltage, current and cos ϕ. The reactive or wattless energy is, however, proportional to the product of the quantities voltage, current and sin ϕ, and this product must be made to enter into the tariff formula if the low power-factor consumer is to be penalised in the manner suggested. Various methods of applying this principle are now in use in France. One large company instals a second meter to record the reactive power and charges for the reactive (idle) energy, a price which is one-quarter or one-third the price charged for effective energy. This means that a consumer operating at 0.71 power factor has to pay from 25 to 30 per cent. more per kilowatt-hour than he would if he operated at unity power factor. Another supply company uses a formula involving tan ϕ for consumers whose power factor is between 0.50 and 0.74. If the power factor is below 0.5 the consumer is liable to be refused supply. If the power factor is between 0.5 and 0.74 the excess charge ranges from 17 to 0 per cent. Yet another company uses a tariff formula which involves cos ϕ; the neutral point is taken at the power factor 0.8, below which an increased charge is made, and above which a rebate is allowed. In all three cases the consumers watch with interest the readings of the reactive energy meter for the first month or quarter, but they then realise that it is to their interest that this meter should remain stationary

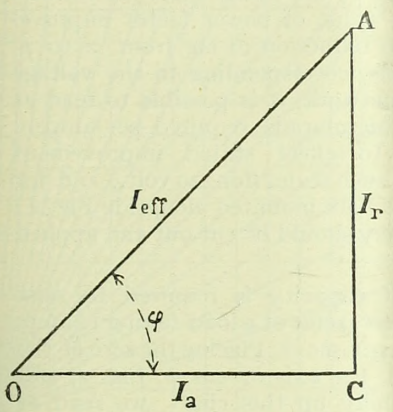


FIG. 1.

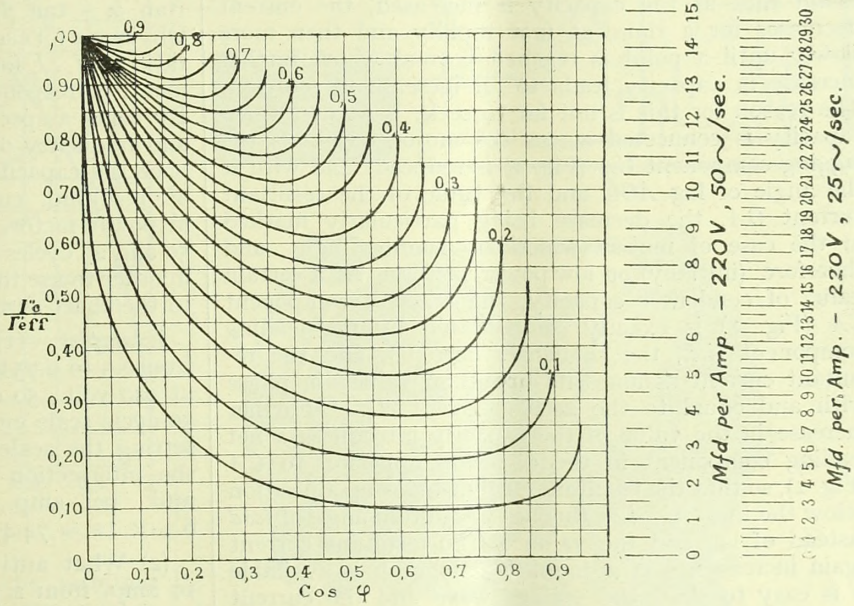


FIG. 2.

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and they take active steps to improve the power factor of their loads! Amongst the means by which this end may be attained, the simplest is the use of static condensers as a source of "anti-reactive" current —to coin a term which helps to avoid confusion in discussing this subject.

The application of static condensers to compensating the reactive current of induction motors is technically simple, and the capacity required for the purpose may be determined easily from the special charts described later. The fundamental relation between the active current I_a and the reactive current I_r is shown by the triangle OCA (Fig. 1), in which I_{eff} represents the resultant current due to the active current OC and the lagging component CA. The greater the reactive component, the greater the angle of lag ϕ of the resultant current.

Subject to certain minor reservations, into which we need not enter at present, the reactive current of a condenser leads the voltage by 90 degs., whereas the reactive current of inductance lags by 90 degs.; thus the condenser current may be subtracted directly from the inductive current CA (Fig. 1), so reducing the angle of lag of OA.

By way of simple example, let us consider a circuit containing a single induction motor with an ammeter in circuit with one of its phases to indicate the current flowing. Across the terminals of this phase let there be connected a variable condenser. Tabulating corresponding values of current and condenser capacity—the load on the motor remaining constant—it will be found that as the capacity is increased, the current decreases for a time, at first rapidly and then more slowly until a point is reached beyond which further increase in capacity leads to an increase in current. The reason for this is not far to seek. At first when capacity is connected across the motor terminals the lagging component CA (Fig. 1) is reduced, and with it the angle of lag AOC and the value of the resultant current OA, the decrease being particularly marked in the case of motors which are running light, and therefore (initially) on low power factor. At a certain value of condenser capacity, the reactive component CA (Fig. 1) is exactly compensated by the leading component (*i.e.*, the condenser current), and the resultant current assumes its minimum value—in phase with and equal to the active current I_a. Further increase in the value of the capacity introduces a net leading component in the direction opposite to CA (Fig. 1), so that the resultant current takes up a position below the line OC—*i.e.*, there is a resultant angle of *lead* instead of lag and the value of the resultant current again increases. If a double oscillograph is available it is easy to show the voltage wave and the current wave of the circuit simultaneously. As the capacity across the inductive load is increased, the current wave decreases in amplitude and moves back more nearly into phase with the voltage wave. When the amplitude of the current wave is a minimum, this wave is in phase with the voltage. Further increase in capacity causes the current wave to lead on the voltage and to increase in amplitude.

Calculating Anti-Reactive Current.—The current taken by a condenser of capacity K farads when connected to a source of supply at V volts, and f cycles per second, is given by $I = 2\pi fKV$ amperes, and the apparent power consumed by the condenser is given by the product IV watts. In order to convey a definite idea of the magnitude of the condenser current and power, values of these quantities for different capacities and for 25 and 50-cycle circuits at 220 volts are given in Table I.

Table I.—Condenser Current and Apparent Power.

	At 220 volt., 50 cycles.		*At 220 volt., 25 cycles.*	
Capacity in Micro-farads.	*Current in Amperes.*	*Apparent Power in Watts.*	*Current in Amperes.*	*Apparent Power in Watts.*
1	0.069	15.18	0.0345	7.59
25	1.725	379.5	0.8625	189.75
50	3.45	759	1.725	379.5
100	6.9	1518	3.45	759
200	13.8	3036	6.9	1518
300	20.7	4554	10.35	2277
400	27.6	6072	13.8	3036
500	34.5	7590	17.25	3795

It will be seen that the current and apparent power both increase in direct proportion to each of the quantities frequency, voltage and capacity.

Charts for Determining Capacity Required.—The curves in Fig. 2 have to be drawn to show the anti-reactive current to be provided to raise the power factor from any one value to any other value.* To reduce the angle of lag of the resultant current from α to β, it is necessary to provide a condenser current $I_c = I(\tan \alpha - \tan \beta) \cos \alpha$; where I = resultant current. Obviously for each value of the cosine there is a definite ratio of $I_c : I$ for each value of power factor improvement, corresponding to reduction of lag from α to β. By using a special scale, corresponding to the voltage and frequency of the network, it is possible to read at once the capacity in microfarads required per ampere of resultant current to effect stated improvement in power factor. Two such scales (for 220 volt., and for 50 and 25 cycles per sec.) are mounted alongside Fig. 2; in order to use them, they should be cut out and applied to the chart as follows:—

Examples.—(1) What capacity is required to raise from 0.5 to 0.75 the power factor of a load taking 12 amp. at 220 volt., 50 cycles per sec.? Placing the zero of the 50-cycle scale on 0.5 on the axis of cos ϕ, Fig. 2, and setting the scale vertically up this chart, we read at the intersection of the 0.25 curve (=0.75 − 0.5), 6.2 mfd., per amp., *i.e.*, the total capacity required is $6.2 \times 12 = 74.4$ microfarads.

(2) What anti-reactive current is required to raise 10 amp. from a power factor of 0.80 to 0.95? The improvement in power factor is here to be 0.15, and we read straight from the chart, above cos $\phi = 0.80$, that $I_c/I = 0.34$, whence the total anti-reactive current required is $10 \times 0.34 = 3.4$ amp., whatever the frequency.

(3) If a two-phase, 220 volt. motor operating on a 25-cycle system takes 10 amp. per phase at 0.7 power factor, what will be the power factor when a condenser capacity of 35 mfd. per phase is employed? The capacity per ampere is 35/10 = 3.5 mfd., and setting

* The figures against the curves in Fig. 2 denote the amount by which the power factor is improved, above the values cos ϕ shown on the base line.

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this capacity on the 25-cycle scale vertically up from the cos $\phi = 0.7$ point on Fig. 2, we find that the improvement effected is 0.07, so that the final power factor is $0.7 + 0.07 = 0.77$. On a circuit of higher frequency, the same capacity would effect a larger improvement in power factor (*e.g.*, to 0.81 in the case of 42-cycle supply).

The capacity per ampere of resultant current required to raise the power factor from a value cos ϕ to some higher value, cos α may be determined conveniently from Fig. 3, using the same scales as shown to the right of Fig. 2 for 25 and 50 cycles per second, and similar scales for other frequencies if required.

Example.—Solving the previous Ex. 1 by aid of Fig. 3, we place the 50-cycle scale on the ordinate through the lower power factor 0.5, with the zero of the scale at the intersection between this ordinate and the circle. Then the radial line representing the higher power factor, 0.75 in this case, cuts the applied scale at 6.2, whence the total capacity required is $12 \times 6.2 = 74.4$ mfd., as before.* If the supply is at 25 cycles, the other scale must be used, and it is then found that the necessary capacity is 12.4 mfd. per ampere, *i.e.*, 140 mfd. altogether.

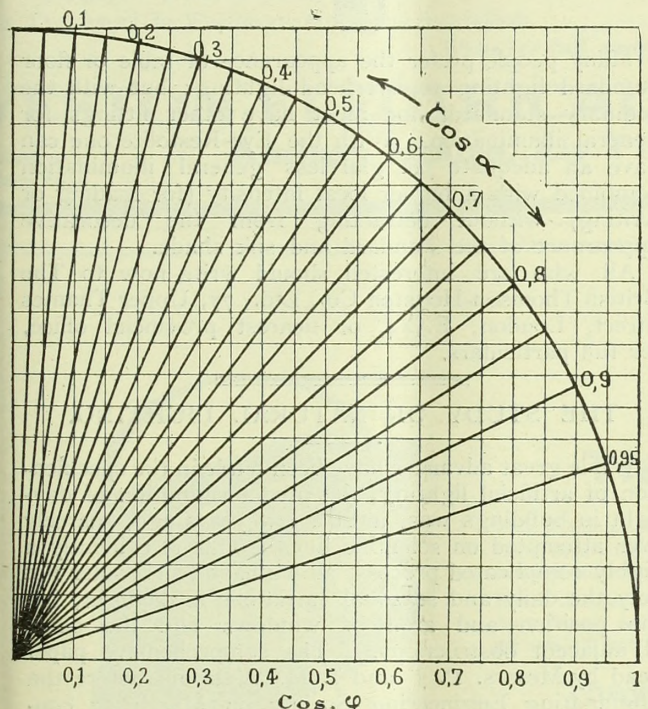


FIG. 3.

In practice it is sufficient to know the resultant current and power factor of an induction motor when running light, then the same condenser which brings the power factor to unity under these conditions will maintain unity power factor at all loads. In other words, the reactive current of the motor is practically the same at all loads, and so, therefore, is the correcting anti-reactive current required.

Tests on a certain two-phase, 4-pole, 220 volt. motor operating on 42 cycles per sec., and consuming 51 amps. at 25 h.p. output (0.88 efficiency), showed that the power factor was 0.1 on light load; 0.5 at 10 per cent. load; 0.82 at 25 per cent. load; and 0.95 at half load and full load. With a capacity of 200 mfd. per phase, the power factor was unity at all loads from light to full load.

If it is desired to avoid penalties by operating above a specified power factor, say 0.75, the graphs should be used to determine the capacity needed to exceed this power factor on light load. The power factor at higher loads will then certainly be above the desired value.

(*To be concluded.*)

* The scale of Fig. 3 has been changed in reproduction; if the diagram be re-drawn to suit the scales in Fig. 2 it can be used as explained in this example.

TWO NOTABLE SAFETY DEVICES.

"Safety first" is the keynote of the Home Office rule which reads:

"In every place in which machines are being driven by an electric motor, there shall be means at hand for either switching off the motor, or stopping the machines if necessary to prevent danger."

How many serious accidents in our large factories would have been averted had the spirit, as well as the letter, of this rule been more generally observed? It is often of vital importance to stop machinery instantly, and the means provided for stopping must be thoroughly dependable and instantly effective.

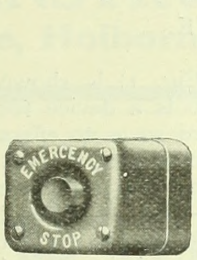


FIG. 1.

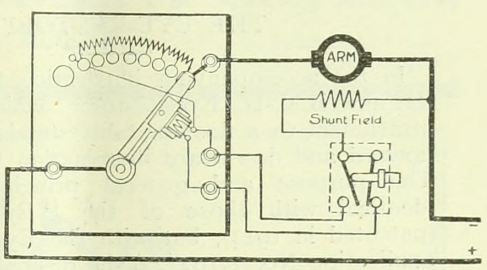


FIG. 2.

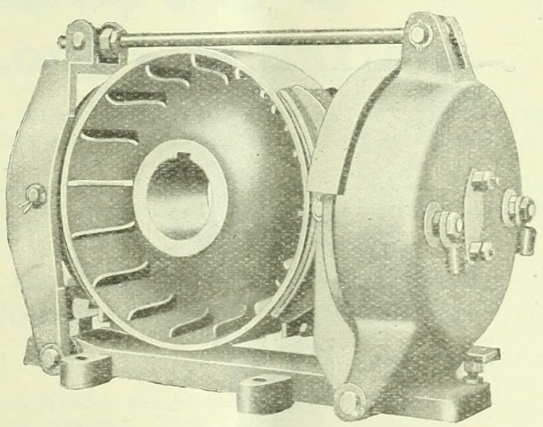


FIG. 3.

The patent Distant Stop Push Button (Fig. 1), which is manufactured and sold by the Igranic Electric Company, Ltd., of 149, Queen Victoria Street, London, solves this difficulty completely, and as, in consequence, it is quite positive in its action in all conditions and any situation, it is claimed that it really complies with the intention of the Home Office rule.

This push button, of which an illustration is appended, has two sets of contacts—one set normally

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closed and the other set normally open. The normally closed contacts place the no-volt magnet coil in series with the shunt field. The normally open contacts, if closed, would provide a path for the field current independently of the no-volt magnet coil. When the button is pressed to stop the motor, it first closes the normally open contacts, thereby providing an independent path for the field current, and then opens the normally closed contacts, thus breaking the circuit of the no-volt magnet coil. The diagram (Fig. 2) shows the application of this button to a shunt-wound motor.

The complement of the Distant Stop Push Button is the Igranic "M" type magnetic brake, illustrated by Fig. 3, for in cases where it is necessary to bring heavy machinery to rest practically instantaneously, to avoid serious accidents, it is not sufficient simply to disconnect the motor from the supply, because the rotating parts may continue to run, or coast, for a considerable time before finally coming to rest. In such cases a brake is necessary which will be applied automatically simultaneously with the opening of the motor circuit and as automatically released when the motor is switched on. The Igranic "M" type brake does this if connected in series with the motor, and it is a very powerful brake. Moreover, it is very simple and robust in construction, consisting of very few parts, and it occupies very little space, which makes it applicable in practically any installation.

THE EYE-RESTOLITE.

In the accompanying illustration (Fig. 1) is shown the new B.T.-H. Eye-Restolite, which is a device for attachment to a floor or table standard so as to effect upward and downward illumination for a single lamp. The purpose and general principle are therefore identical with those of the "Eye-Rest Adaptor" (patented in 1914), but with the Eye-Restolite (patent application No. 35192/22) the desired result is effected with one lamp, whereas the earlier design needed several.

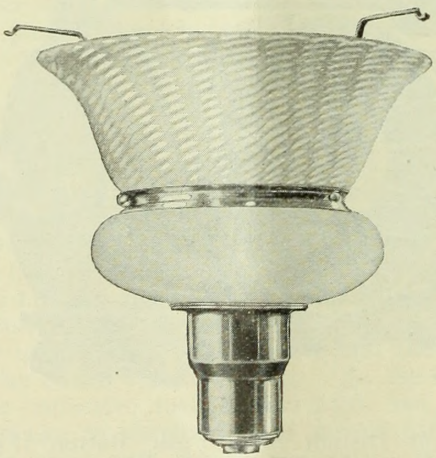


Fig. 1.

The Eye-Restolite unit (Reg. No. 692033) consists essentially of an X-Ray reflector above and a diffusing bowl below, the lamp being held between the two. The major part of the light is thrown upwards by the reflector, but local illumination sufficient for reading and close work is diffused downwards by the glass bowl. To enhance the illumination of the silk shade, which is supported by the framework securing the lamp-holder, the exterior of the reflector is white enamelled (see Fig. 2). Both reflector and diffusing bowl can be easily removed for cleaning.

The lower end of the device is threaded for attachment to any ordinary floor or table standard. Three sizes are made: for gasfilled lamps of 100 watts, 150 watts, and 200 watts, the first being fitted with a B.C. holder and the two larger sizes with E.S. holders. All sizes are retailed at the same price.

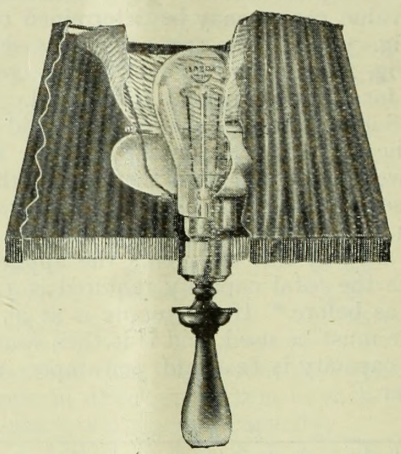


Fig. 2.

Many people prefer the appearance of table or floor standard lighting to overhead lighting; but with the ordinary standard, one must have other fittings for general illumination. With the Eye-Restolite one can have an adequate yet glareless general illumination combined with a higher local intensity (for reading or writing) without detracting from the decorative appearance of the standard and silk shade.

All who are interested should write now to The British Thomson-Houston Co., Ltd., 77, Upper Thames Street, London, E.C.4, or nearest provincial office, for full particulars.

THE STUDY OF NATURAL LIGHTING.

While great advances have been made in the specification of artificial lighting, the predetermination of daylight in buildings was, until a few years ago, scarcely ever attempted on scientific lines. This is evidently a highly complicated process, as we have to consider not only the daily and seasonal variations in daylight, but the position and area of windows and the effect of adjacent obstructions. The comprehensive paper read by Messrs. P. J. and J. M. Waldram before the Illuminating Engineering Society on March 27 contained a useful survey of the subject and showed how estimations of access of daylight may be made. A general invitation was extended to members of the R.I.B.A. and the Surveyors' Institution to take part in the discussion, and no doubt their interest in this subject will lead many of them to pay greater attention to artificial lighting. While the planning of the access of daylight is mainly a matter for the consideration of members of the architectural profession, it is interesting to see how experience gained by illuminating engineers in the measurement of artificial light is coming to their aid. In course of time apparatus for daylight measurement may come to be used as freely as photometers applied to artificial lighting installations, and in several recent "ancient light" cases it has already proved to be of material value.

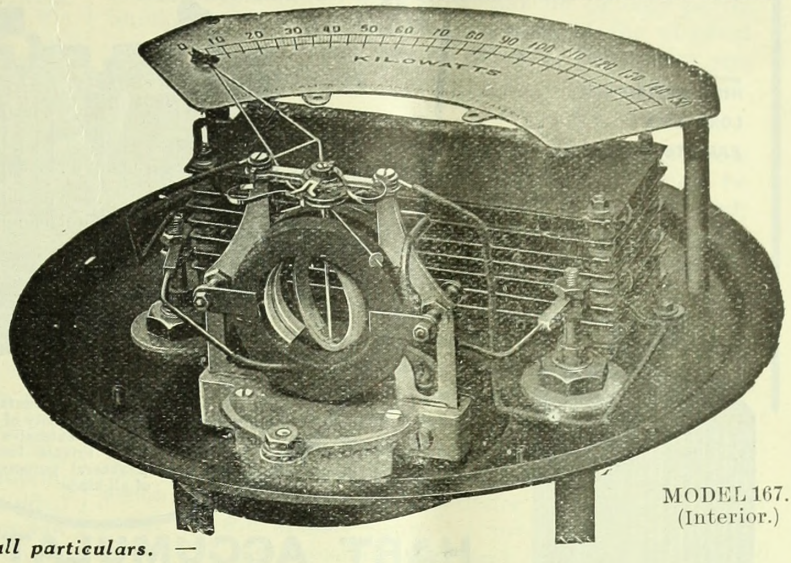
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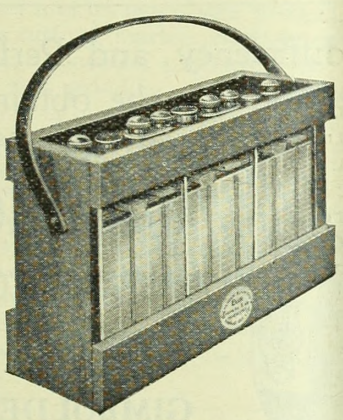
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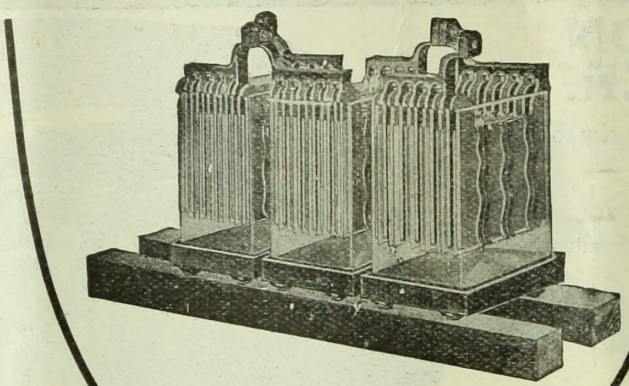
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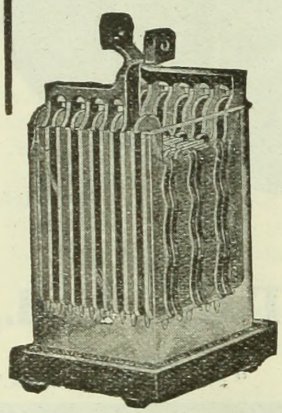
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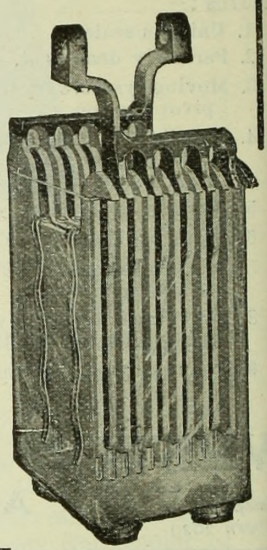
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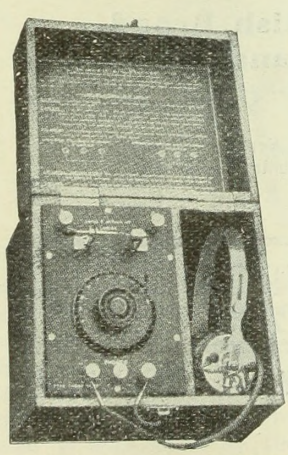
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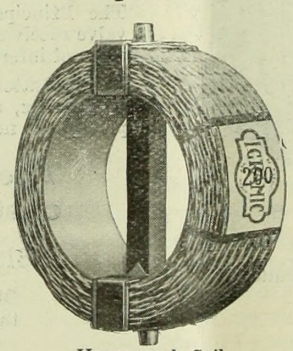
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New advertisements for the displayed columns and alterations to existing ones must reach the publishing office not later than first post Tuesday morning, in order to be in time for the issue of the following Friday. This is important. Rate quoted on application. Subscription: 13s. a year, 6s. 6d. half year, 3s. 3d. a quarter in advance, postage prepaid in the United Kingdom and abroad.

Questions to which an answer is required must be accompanied by a 1½d. stamp for reply. When considered of sufficient interest, the answer will probably appear in the paper.

All remittances payable to the Publishers, S. RENTELL AND CO., LTD., 36-39, Maiden Lane, London, W.C.2. Telephone No. 2460 Gerrard.

Current Topics.

Film Propaganda.

Last week I was privileged to witness a most interesting and educational film depicting the development of the carborundum industry, and the manifold and ever-increasing applications of this marvellous artificial abrasive in many widely divergent fields of manufacture. We saw the Niagara Falls power plant; the filling, functioning and opening of the immense electric furnaces in which carborundum is manufactured; the processes by which it is moulded into wheels and discs of various forms and sizes to suit different requirements, and, finally, its extraordinary applications in industry. Like most readers, I was, of course, familiar with the modern development of high speed precision grinding in engineering works, but until I saw this film I had no idea of the extent to which grinding had displaced the older and more laborious and costly processes of machining and milling.

Furthermore, there was abundant food for reflection in the number of diverse applications of the abrasive process of removing material. For example, carborundum and its associated product, aloxite, are used for glass cutting, marble polishing, shaping ivory piano keys, pearl buckles, producing the suède surface on leather, lens grinding, etc., all alien to the original application in purely engineering workshops. We saw large slabs of granite being cut like cheese by means of a high speed carborundum disc, and, with equal facility, saw teeth were formed and set, and such rough engineering products as ploughshares and cast bath tubs roughed and polished to the requisite surface. There seemed to be no end to the applications of this modern manufacturing process, and great credit is due to the Carborundum Company for their enterprise in developing the field of usefulness for their principal products.

The moral of these notes, however, is not only to study the possibilities of carborundum in your own industry or workshops, although it might well repay you to do so, but mainly to instance the invaluable services which a carefully prepared film can render in the matter of advertising or educating the interested public into the possibilities and applications of any given product. This is an age when the younger generation especially are keen for general information, and there is nothing better calculated to interest as well as instruct than a cleverly conceived film presentation of the subject. It is far more convincing than any amount of letterpress or ordinary illustrations. Whenever it has been my mission to familiarise a person with a new product, mechanism, or process, I have always endeavoured to show him the actual article, if possible in a state of motion. It saves hours of involved and tedious explanations very often difficult or only partly intelligible to one's audience, because of the physical impossibility of seeing eye to eye with the person you are trying to educate.

Show him the actual machine, apparatus or process in being, however, and, given ordinary intelligence, he grasps the whole principle in a matter of seconds, and, moreover, the interest endures and prompts intelligent inquiries into details. It is not always possible to arrange such an actual demonstration, or even a sight of the real thing, and it is here that the motion picture steps in a fill the gap. To my mind there is nothing better than the cinema for this purpose short of seeing the real thing; and, in fact, by cleverly arranged "close-ups," it is sometimes possible to depict movements which would ordinarily be invisible even on the real mechanism, owing to the speed of movement, which, on the film, is brought under control and within range of the human vision. I predict a very great future for the industrial film, and it is a subject the E.D.A. might consider with advantage as a means of electrical propaganda.

Railway Grouping: Will It Foster Development?

Whilst the new scheme by which most of the British railways are grouped under comparatively few heads will undoubtedly make for more economical working and management, one wonders whether the revolutionary scheme will also have the much-to-be-desired effect of breaking down conservatism and prejudice which has so seriously hindered railway progress in this country in the past. It is a well-known fact that there were no more conservative undertakings in this country than the independent railway companies of the past. Only an earthquake or a landslide would induce them even to consider new ideas or suggestions for improved operation, modern signalling methods, electric propulsion, train lighting, and a hundred and one other details now common to American and some Continental railways.

Moreover, each company had its own ideas on standard designs, and was correspondingly jealous of any proposed innovation or departure from accepted standards and specifications handed down through generations of railway men. The brake of tradition was always on the wheels of the rolling-stock, and the inordinate amount of fuss that ensued over the original abandonment of the old broad gauge on the Great Western will still be fresh in the memories of the older generation. By their past neglect to march with the times in other industries, our railways have a good deal of leeway to make up. The speedy conversion of all rolling-stock of the passenger class to electric lighting should be one of the first duties under the new grouping, as should also the adaptation of modern systems of signalling, which have now been brought

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to such a pitch of perfection as to render accidents directly attributable to the signalling system practically impossible.

Automatic locks for railway carriage doors are another example of railway conservatism. It is due to an ancient recommendation of the old Railway Department of the Board of Trade that the carriage doors of trains making a non-stop run of thirty miles should be kept unlocked, that inventors of automatic locks, expressly designed to prevent accidents and fatalities due to insecurely fastened doors, have met with no encouragement. Average annual fatalities due to this cause alone number eleven, and in the first three months of the present year no less than six such fatalities have occurred, every one of them preventable had automatic door locks been adopted years ago as standard equipment on passenger coaches. The hoary old objection that, in case of disaster or collision, passengers would be imprisoned in the coaches and unable to extricate themselves from the wreckage no longer holds good, because it is quite practicable to design a series of electrically controlled locks which would be instantaneously and automatically released in the event of accident.

Then as to the general question of electrification; will the new grouping expedite or retard development in this field? A good deal depends on the ultimate controlling personnel and their individual ideas on the subject. We want live men with progressive ideas at the head of our railways, and the new grouping should facilitate the appointment of such men and the removal or superannuation of those who have so long retarded progress and development in the railway field. The development of road transport has been brought about by a younger and more progressive element than were responsible for the operation of the railways during recent years, and the result is a striking object lesson in what happens to an industry which stagnates instead of adopting modern methods and conditions. Let us hope that the responsible heads of affairs under the new railway grouping scheme are fully alive to the facts, and will lose no time in making their recommendations for much-needed improvement.

Slogans Wanted.

Friend Beauchamp, of E.D.A. fame, wants some good slogans in order to keep on boosting electricity. Not this paper, but the whole industry, in which, I may say, we like to think we are included. It is a jolly good idea, and the E.D.A. council offer cash prizes of £10, £5 and £3 for the three best slogans or phrases sent in during the months of May and June, 1923. Fuller particulars are given in our advertisement columns, but I want to direct the attention of as many readers as possible to a competition which should most certainly have very beneficial results. To start with, a tenner is always handy, whether used by a central station engineer for the purchase of a new dress suit or to spend in sending the wife and kids to Southend if you are a London member of the E.T.U., or Blackpool if you live up north. Then there is the value of a good slogan as a capital catchy advertisement of the whole industry. I trust, therefore, that my readers will enter wholeheartedly into the competition, and what is more, that they will win all three prizes. Go ahead.

Elektron.

ELECTRICAL ENGINEERING.—FINAL GRADE

Solutions to 1922 Examination Questions of the City and Guilds Institute.

By Edward Hughes, B.Sc. (Eng.), A.M.I.E.E.

(*Continued from page* 190).

Q. 15.—500 kW. at 11,000 volts are received from a 3-phase transmission line, each wire of which has a resistance of 1.2 ohms and a reactance of 1.0 ohm. Calculate the supply pressure when the power-factor of the load is (*a*) unity, (*b*) 0.5 leading.

A. 15.—(*a*) For convenience of calculation, it will be assumed that the load is connected in star; the result is not thereby affected.

In Fig. 17, *OI* represents the line or phase current, and *OV* the voltage across that phase at the receiving end. The voltage drop in the line due to resistance is represented by *OA* in phase with the current, whilst the voltage drop due to reactance is indicated by *OB*,

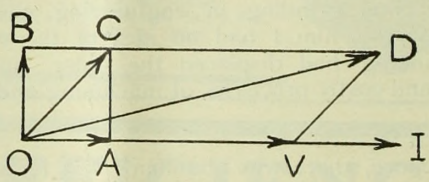


Fig. 17.

leading 90° in front of the current. The diagonal *OC* of the parallelogram formed by *OA* and *OB* gives the voltage drop due to the impedance of the line. The voltage per phase at the transmitting end is given by *OD*, the resultant of *OV* and *OC*.

From the data given in question, we have—

$$OV = \frac{11{,}000}{1.73} = 6{,}350$$

and $$OI = \frac{500 \times 1{,}000}{1.73 \times 11{,}000} = 26.3$$

$$\therefore \quad OA = 26.3 \times 1.2 = 31.6$$

and $$OB = 26.3 \times 1.0 = 26.3$$

Hence $$OC = \sqrt{(31.6)^2 + (26.3)^2} = 41.1$$

and $$\cos COA = \frac{OA}{OC} = \frac{31.6}{41.1} = 0.769$$

Also $$OD^2 = OV^2 + OC^2 + 2OV \times OC \times \cos COV$$
$$= (6{,}350)^2 + (41.1)^2 + 2 \times 6{,}350 \times 41.1 \times 0.769$$
$$= 4{,}080 \times 10^4$$

$$\therefore \quad OD = 6{,}388$$

= phase voltage at transmitting end;

$\therefore$ line voltage at transmitting end

$$= 1.73 \times 6{,}388 = 11{,}050.$$

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(*b*) Since the power is unaltered, the current will be doubled ; hence we have for Fig. 18—

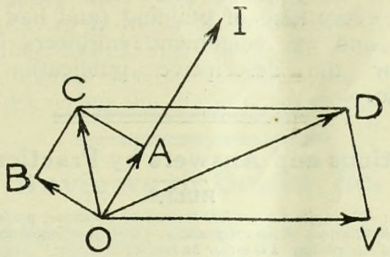


FIG. 18.

$$\left.\begin{aligned} OI &= 2\times 26.3 = 52.6 \\ OA &= 52.6\times 1.2 = 63.2 \\ OB &= 52.6\times 1.0 = 52.6 \end{aligned}\right\}$$

$$OC = \sqrt{(63.2)^2 + (52.6)^2} = 82.2$$

and cos COA = 0.769

$\therefore$ $C\hat{O}A$ = 39° 38′

Also cos IOV = 0.5 leading

$\therefore$ $I\hat{O}V$ = 60°

But $C\hat{O}V$ = $C\hat{O}A + A\hat{O}V$

= 99° 38′

Hence OD^2 = $(6{,}350)^2 + (82.2)^2$

$+ 2\times 6{,}350\times 82.2\times \cos 99°\ 38'$

= $3{,}938\times 10^4$

$\therefore$ OD = 6,270

$\therefore$ Line voltage at transmitting end

= $1.73\times 6{,}270 = 10{,}850$.

The voltage drop in the line in the above example is abnormally low, and it would appear that an error was made in the data.

(To be continued.)

STROWGER AUTOMATIC TELEPHONES FOR DAIREN (DALNY), MANCHURIA.

The official opening on April 1 of a new Strowger Automatic Telephone Exchange at Dairen, Manchuria, marks the second stage in an era of Automatic Telephone Development in the Far East, the important railway centre of Harbin being already equipped with a Strowger Automatic Telephone system which was put into service in 1921 and serves 3,000 subscribers.

The new Dairen installation at present serves 5,200 subscribers, and, like that previously installed at Harbin, was manufactured and installed by a British firm, Automatic Telephone Mfg. Co., Ltd., Liverpool, who secured both contracts in the face of foreign competition. This firm has now supplied some sixteen public and private automatic exchanges to the Far East, including a 400-line equipment to the G.P.O., Tokyo.

The fact that these installations are working successfully some 12,000 miles distant from the point of manufacture is a tribute not only to the proved commercial practicability and reliability of the Strowger Automatic Telephone System, but also to the engineering and manufacturing ability of the British sponsors of this system, which is the one also adopted by the British Post Office for the automatic telephone exchanges at Leeds, Portsmouth, Blackburn, Accrington, Paisley, and other towns.

It will be remembered that this firm recently secured the contract for 11,000 automatic lines for Bombay, and this equipment is now being installed.

TELEGRAPHY.*

Being Solutions to the Questions set by the City and Guilds of London Institute at the Final Grade Examination in Telegraphy held in May, 1922.

COMPILED BY A SILVER MEDALLIST.

(*Continued from page* 189)

Q. 8.—Give a diagram of a wireless receiving station using valve amplifiers. Explain the action of the various parts.

A.—Fig. 1 represents a wireless receiving station using valve amplifiers. Valves *A*1 and *A*2 are used for the amplification of the incoming high frequency oscillations, while valve *V* is used for rectification purposes.

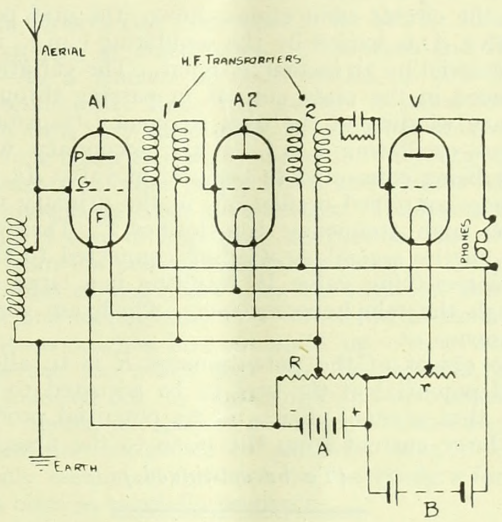


FIG. 1.

The thermionic valve consists of an exhausted glass bulb containing three electrodes *P*, *G* and *F*, which are known respectively as the plate, grid and filament. The filament is heated to incandescence by means of a battery *A* and controlling resistance *R*; in such circumstances it emits a stream of minute negative charges of electricity called electrons. Assuming first of all that there is no grid *G* in the bulb, then, if the plate *P* is maintained by means of battery *B*, as shown at a positive potential with respect to the filament *F*, it will attract a large number of the electrons, causing in effect a flow of positive electricity from the plate to the filament. Under these conditions the space between the filament and the plate becomes a conductor of electricity, but possesses the peculiar property of conducting in one direction only, viz., from *P* to *F*. The current resulting from the voltage applied between *P* and *F* does not comply with Ohm's law; up to a certain

* Consult also "Questions and Solutions in Telegraphy and Telephony," Final Grade, by Few, 2s. 3d. post free from ELECTRICITY Office.

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voltage the rise of current resulting from an increase in voltage is extremely small, whilst beyond a particular point a very large increase of current is produced by a very small voltage increase. When the voltage applied exceeds a certain value, a further increase produces practically no change in the current; this is due to the fact that the number of electrons liberated per second from the filament is limited, being dependent upon the size of the filament and its temperature. The introduction of the grid *G*, consisting of metal gauze, between the filament and plate practically prevents the flow of electrons to the latter. The grid becomes negatively electrified by the electrons and consequently tends to repel them, thus shielding the filament from the effect of the positive plate and rendering the valve non-conducting. If, however, the grid potential is reversed by applying an external e.m.f., its shielding effect will be neutralised and the valve will become conductive, so that a current may pass from the plate to the filament through the battery *B*. Now the capacity of the grid is negligible, so that only an exceedingly small amount of energy is necessary to reverse its potential, and as a result allow a large current to pass from the battery *B*.

In the circuit connections shown, the grid potential of valve *A*1 is varied by the oscillating e.m.f. induced in the aerial by an incoming signal. The variation thus produced in the plate current in passing through the primary winding of the high frequency transformer 1, induces oscillating e.m.f. in the secondary winding, which being connected to the grid of valve *A*2, in turn produces amplified oscillations in the primary winding of the high frequency transformer 2. These in turn react on the secondary winding connected to the grid of the rectifying valve *V*, resulting in a large current through the telephone receivers, which are connected as shown.

The object of the potentiometer *R* is to allow the initial potential of the grid to be adjusted to such a value that a small change in its potential produces a very large current from the plate to the filament.

(To be continued.)

THE PRESCOT WIRING SYSTEM.

The Prescot wiring system, designed by British Insulated and Helsby Cables, Ltd. (Prescot, Lancs), over 25 years ago, is described in an instructive publication recently to hand. In its simplest form, the system consists of twin paper-insulated lead-covered wire, with soldered joints, the joint after insulation being covered with sheet lead soldered round the edges and the lead sheath. Cast metal bases, to which the lead sheath is soldered at light and switch points where necessary for bonding purposes, are supplied. As, of necessity, the soldering must be carefully done, the company have for several years past supplied a complete range of cast-iron fittings with glands to ensure continuity of the lead sheath.

The dielectric is of a very lasting nature, as will be appreciated, and as an example we might mention the case of some business premises which were equipped when the system was first introduced, and just recently when the premises were being rebuilt the old wire was found to be in such good condition that it was used again in the new circuits. In another case it was used in a large power-station for the lighting circuits, and in spite of the heat is still giving every satisfaction.

The Prescot system, being neat, is suitable for use in almost every kind of building (and has in fact been so used), and we recommend engineers interested to apply for the descriptive publication previously referred to.

Questions and Answers by Practical Men.

RULES.

Questions: *We invite our readers to send us questions, preferably on technical problems that have arisen in actual practice. Questions which we consider of sufficient interest to our readers will either be replied to under "Answers to Correspondents" or replies will be invited from our readers. One shilling will be paid for the question which we select for competitive replies in this column.*

Answers: *A fee of 10s. will be paid for the answer which we consider shows the greatest merit, and 5s. for the one we select as second best. In judging the replies, importance will be attached to clearness and conciseness, as well as accuracy. The Editor reserves the right to make no award, or to accept only one reply, if, in his opinion, the answers received do not possess sufficient merit. Competitors desiring the return of their manuscripts, if unaccepted, should enclose stamped addressed envelope.*

Write on one side of the paper only, and if diagrams are sent, draw them on a separate sheet of paper attached to the manuscript. Competitors may adopt a "nom de plume," but, both in the case of questions and answers, the competitor's real name and address must be sent with the manuscript as a guarantee of good faith. No correspondence will be entered into with regard to successful replies. The Editor's decision is final.

Commencing with Question No. 101, a Diploma of Merit will be awarded to the six competitors who win the first or second prize the most times during the next twelve months.

The words "Questions and Answers" or "Q" and "A" should be placed at the top left-hand corner of all letters intended for this column.

Question No. 157.

Can any reader give me details from which I can make a Nodon Valve to enable me to charge accumulators from an A.C. supply? What is the action of such a valve?—"Wireless."

Question No. 158.

I have to repair a number of accumulators. My difficulty is that I do not know how to connect the bridge pieces, that is, the bars which are connected across the top of each set of plates. I understand that these are "burnt" on. How is this done?—"Accumulator."

(Replies to Questions 157 and 158 must be received not later than April 28, 1923.)

RILEY COMBUSTION FILM.

Mr. Charles Erith, A.M.I.Mech.E., exhibited on April 11 to a largely attended meeting of the Electrical Power Engineers' Association at Liverpool University, a moving picture showing the actual processes of combustion in a large modern boiler, at loads varying from banked fires to about 9 lb. per sq. ft. heating surface. The boiler was fitted with a Riley moving-grate, retort-type stoker, carrying a thick bed of fire, the incandescent surface of the entire fuel bed radiating direct to the boiler tubes, exactly similar to the one recently ordered for a large new boiler at Worcester Corporation Electricity Works. Reference was made to the very large Riley Stokers in British, French, American, Indian, Australian, Chinese, and Japanese Central Stations under all types of water-tube boilers.

Mr. Erith described the methods of protecting the lens of the camera, whereby it had become possible to obtain a satisfactory picture of combustion at a furnace temperature of 3,000 deg. Fahr.; and how by snapping pictures at intervals, so that four hours of actual stoker operation are shown in only two minutes, the actual motion of the coal through the furnace is clearly shown on the film, though its travel is too slow for ordinary observation.

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The film showed how, in only six minutes, starting from banked fires, the rate of combustion was increased until the boiler duty was brought up to 70,000 lb. steam hourly, or about 9 lb. actual steam per sq. ft., corresponding to 300 per cent. on American boiler rating, by merely increasing the speed of the Riley Stoker, and varying the draught pressures of the fans.

Reviews of Books, &c.

[Books noticed in this column will be sent from Electricity *Office to any part of the world, for the published price, plus ten per cent. for postage (minimum 2d.) and orders will be appreciated.]*

Electric Wiring. By Clinton. Seventh edition. (Murray, 3s. 6d. net.)—This book has had a very wide circulation since its first appearance in July, 1902, and the 198 pages contain a vast amount of information of direct value to wiremen and students, for whom it has been specially written. In this edition the new notation for cables has been substituted for the old, and some obsolete matter has been omitted as well as various additions made, in order to keep the book thoroughly up to date. It is recommended by the City and Guilds Institute, and can, therefore, be looked upon as a work which will repay the careful study of those for whom it is written.

Special Steels By T. H. Burnham. Cl., 8vo, 194 pp., 40 illus. (Pitman, 5s. net.)—This is an exceedingly interesting addition to the excellent series of primers which are now being issued by Messrs. Pitman. It is really a concise treatise on the constitutions manufacture, working, heat treatment, and applications of alloyed steels and has been chiefly founded on the researches of Sir Robert Hadfield, Bart., who has written a foreword to the book. To students, operators and users of special steels generally we can most cordially recommend it as giving a concise technical survey of this important branch of metallurgical science. It is remarkably up to date and deals with many steels which have only recently been developed, and we have every reason to believe that it will meet with a very favourable reception from all who are in any way associated with steel and its uses.

The Engineer's Year Book for 1923. By H. R. Kempe. 2,800 pp., illustrated. (Lockwood, 30s. net.)—We give our usual hearty welcome to our old friend who waxes ever more corpulent in spite of the careful way in which his editors eliminate every bit of waste flesh, or rather redundant literature. Therefore, he is as indispensable as ever, and we tremble at the thought of troubles and failures which might occur to the engineer who has by him no copy of this engineering compendium. His plight must be tragic, and we give to all such the soundest possible advice : get a copy of the new edition without delay. It covers the engineering field so thoroughly and so well that it will appeal to every one of our readers, and we can recommend it without hesitation and without claiming to have read every individual page between its bright red covers.

Electric Cranes and Hauling Machines. By F. E. Chilton. 114 pp., 49 illustrations. (Pitman, 2s. 6d. net.)—This is another of the excellent primers which Messrs. Pitman are now issuing under general editorial control of Mr. R. E. Neale, B.Sc., whose name is now so well known in the electrical profession, and we can extend our most cordial congratulations to the author, Mr. Chilton, on the production of a work for which there has been an unsatisfied demand for quite a long time. A very large number of electrical engineers are directly interested in the construction and working of electric cranes and hauling machines, and in the majority of cases their pockets have not been deep enough to permit them to invest in the large and expensive text books which have hitherto been the only available sources of information. In this primer Mr. Chilton deals clearly and in an eminently practical manner with the methods of operation of the majority of the ordinary types of electric cranes and winches, and as the text is accompanied by numerous excellent diagrams and illustration we are confident that the book will find a very large sale throughout the United Kingdom. It is well printed, and reflects great credit on author and publisher alike.

Line Charts for Engineers. By W. N. Rose. Cl. 8vo., 95 pp., 47 illustrations. (Chapman and Hall, 6s. net).—As a teacher of mathematics at the Borough Polytechnic Mr. Rose has gained a name which is known to a very wide circle of personal students, but that circle bears no comparison to the very large number of students in other polytechnics and classes who gain their knowledge from his writings. He has a remarkably lucid way of imparting instruction, and this new book from his pen will appeal to many of the younger generation of engineers who are keen on the use of charts and monograms as a direct aid to time saving. Mr. Rose teaches how to build up charts according to the use for which they may be required, and we have followed out his reasonings and instructions with much interest, particularly in regard to those for Ohm's law and the resistance of platinoid wire. We can cordially commend the book to the readers for whom it has been so carefully prepared.

NEW BOOKS.

"Tables and Units for Engineering Students." By Walker and Ibbetson. Demy 8vo, 40 pp., 32 illus. 1s. net.
"Electric Cranes and Hauling Machines." By F. E. Chilton. 114 pp., 49 illus. 2s. 6d. net.
"Industrial Electric Heating." By J. W. Beauchamp. 118 pp., 42 illus. 2s. 6d. net.
"Electric Wiring." By W. C. Clinton. 7th edition. Cloth, 198 pp., 105 illustrations. 3s. 6d. net.

Personal.—Mr. H. S. Aspinall, who recently resigned his appointment as sales manager and director of the Keighley Gas and Oil Engine Co., Ltd., has been appointed general sales manager to Messrs. Vickers Petters, Ltd., of Ipswich Works, Ipswich, manufacturers of vertical two-cycle oil engines for stationary and marine purposes. His headquarters will be at Vickers Petters' Works at Ipswich.

Wireless on Fishing Vessels.—Some thirty British steam trawlers have now been fitted with wireless apparatus by the Marconi Co., and it is anticipated that considerable benefit will accrue to enterprising owners from the use of this equipment, and experience has shown that wireless communication between skippers and owners has been of great value. The trawlers so far equipped are the property of owners at Cardiff, Milford Haven, Fleetwood, Hull and Grimsby, and it is expected that the list will soon be extended.

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Trade Notes.

Circular No. 10, dealing with Direct Acting Boiler Feed Pumps, has just been issued by **Plant and Supplies, Ltd.**, of 12/13, Henrietta Street, London, W.C.2. It should prove of interest to all central station engineers and others who have steam plant under their control.

Pamphlet H91 deals with the Helsby Magneto Mine Exploder Shot Firing Cables and Accessories, as made by the **British Insulated and Helsby Cables, Ltd.**, of Prescot. It gives illustrations and clear details of the different types of exploders which the company supply to meet the various requirements of mine managers, etc., as well as specifications of the wires, cables and accessories which go to form the complete outfit. It will interest all mining engineers in this country and in the Colonies.

A 4-pp. circular just issued by the **Midland Electric Manufacturing Co., Ltd.**, of Barford Street, Birmingham, gives details and illustrations of the new M.E.M. Fuseboard of the latest cradle type. These fuseboards are excellent time-savers in installation work, as well as representing a well-turned-out job, and that they give complete satisfaction may be gauged from the fact that over 10,000 were sold in 1922. The circular is worth writing for, and should certainly be in the possession of every installation contractor.

A neatly-printed catalogue of Lister-Bruston Automatic Electric Light and Power Plants has just been issued by **Messrs. R. A. Lister and Co., Ltd.**, of Dursley, Glos. It contains illustrations of various important buildings in which these automatic plants are already in use, as well as particulars of the engines, batteries and component parts which go to form this well-known system. It should be in the possession of all installation contractors, and we recommend early application for copies.

No. 2 of the Sunco monthly price list of electrical supplies has just been published by the **Sun Electrical Co.**, of 118, Charing Cross Rd., London, W.C.2. It contains the usual mass of prices of standard lines for electrical engineers and contractors, as well as of certain special wireless sets, for which there should be a ready market, and we can only say that if there is an electrical contractor who has not yet received a copy he should make a point of writing to the company and asking for it at once.

A catalogue of electric-light fittings for all industrial purposes has just been issued by the **Engineering and Lighting Equipment Co., Ltd.**, of Sphere Works, St. Albans, Herts. It is well printed and illustrated, and so bound that subsequent lists can be added in the same binding case without any difficulty. The entire range of fittings listed in the catalogue is constructed to take the company's well-known "Anti-Break" vibration absorbers and thus save damage to the lamp filaments, thereby reducing maintenance costs to a minimum.

A new paste flux for soldering purposes is now being placed on the market by the **Electric Flux Manufacturing Co., Ltd.**, of Wellington Place, Wellington Street, Redditch. It is claimed for it that it is absolutely non-corrosive and will assist the solder to combine with the metals to be soldered and also help it to flow. It is therefore directly suitable for all electrical connections, because it contains no acid and there is no fear that the joint will ultimately be corroded and destroyed. The tins are to be put on the market at 6d. each, and interested readers should make a point of writing for circulars without delay.

A circular dealing with the Herbert Pendulum Hardness Tester has just been issued by **Messrs. Edward G. Herbert**, of Atlas Works, Chapel Street, Manchester. It will be of direct value to all who are in any way interested in testing the hardness of substances which may range from lead to sapphire, and is especially applicable to hardened steels. The list is certainly well worth careful perusal.

Wireless to South America.—A new commercial wireless service between Great Britain and the South American Republic of Colombia was inaugurated recently.

Various Items.

Good News.—At a meeting of the Newport (Mon.) Corporation last week it was resolved to make further extensions at the Electricity Works, and to duplicate the orders recently placed with the Spearing Boiler Co., Ltd., for boilers.

Exhibition.—The Society of Motor Manufacturers and Traders, Ltd., of 83, Pall Mall, S.W.1, has decided to hold at Olympia from Thursday, November 22, to Saturday, December 1, an exhibition of commercial motor vehicles and their components and accessories as well as of the plant, machinery and materials used in the construction, maintenance and development of roads.

The E.D.A. Council.—A new Council was appointed at the annual meeting on March 16. Space does not permit us to give the full list, but we notice a few well-known names among the new members. For instance, Mr. E. E. Sharp, of Venners, has been added as a representative from the Beama, and "Bobby" Smith, of Drake and Gorham Wholesale, Ltd., represents the Electrical Wholesalers' Federation. Altogether, it is a strong Council, and one which is likely to help Mr. Beauchamp in his forthcoming campaign.

Meetings.—The Junior Inst. of Engineers will meet at 39, Victoria St., Westminster, S.W. 1, on Friday, 20th inst. Lecturette, "The Business of Engineering," by H. N. Munro (Member). Also on the 27th inst., Lecturette, "Stock Control," by J. Fearn (Member); and on May 4, Lecturette, "A.C. Neutral Point Earthing," by S. A. Stigant (Member), slides. All at 7.30 p.m.——The Inst. of Production Engineers will meet at 7.30 p.m., on Friday, 27th inst., at the Engineers' Club, Coventry Street, London, W.1. Paper, "The Efficient Tooling of Automatics," by Mr. L. C. Keen. All interested are invited to attend, whether members of the Inst. or not, and no tickets are necessary.

A Promising Student.—Mr. Basil Mott, C.B., vice-president Inst.C.E., presented the certificates on Tuesday to the students of the Crystal Palace School of Practical Engineering, one award being the medal of the school to Mr. Leonard Jarrand for having gained eight certificates out of a possible nine during his course, none below third in order of merit. Mr. Mott, in his address, said he did not know any profession which benefited the human race to such an extent as that of the engineer. It was a profession of intense interest, and directly or indirectly influenced the lives of them all. Marvellous as had been the strides of surgery since the war, where, he asked, would surgery be without the engineer, because of the wonderful instruments constructed?—why, surgery would be helpless. He praised the school very highly, and referred to the number of pupils now holding high positions in the profession, who owed their early training to Mr. J. W. Wilson, the Principal, and Mr. Maurice Wilson, the Vice-Principal.



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A POPULAR SCIENTIFIC WEEKLY JOURNAL
ELECTRICITY
A PRACTICAL TRADE JOURNAL

APRIL 27, 1923.

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G.E.C. OIL-IMMERSED CONTROL GEAR.

We have recently received two leaflets from the General Electric Co., Ltd., Magnet House, Kingsway, W.C.2, and Witton Works, Birmingham, etc., giving particulars of certain ranges of their oil-immersed motor control.

The first leaflet (Technical Description No. 228) contains particulars of oil-immersed rotor starters. These are designed in two patterns, the first suitable for ordinary industrial purposes and the second for fiery mines. Several standard sizes are manufactured ranging from 10 h.p. to 240 h.p.

A general idea of the construction of these units will be obtained from Figs. 1 and 2, which show interior and exterior views respectively. It will be noted that the resistance contacts are at the top of the oil tank so as to enable inspection to be carried out without lifting the unit completely out of the tank, but ample provision is made for a large head of oil above them. The resistances are wound on poreclain bobbins which are secured to the slate base on which the contacts, movable arms, etc., are mounted. The bottom of the porcelain bobbins are fixed to wrought iron straps which act as stays and prevent damage during transit.

The general pattern of tank is of welded steel, but in the flame-proof tank a special method of construction has been adopted. The usual machined joints are provided at the top.

Apart from the fact that the resistance contacts are near the top of the tank, every provision has been made in other respects for inspection. Thus a special inspection cover seen at the right-hand bottom side of Fig. 2 fits over the back of the lid; the removal of this enables preliminary inspection to be made. In the case of the design for use in fiery mines, a screwed inspection plug is fitted.

A step-by-step slow motion device is provided, and in both designs provision is made for conduit or cable boxes, so that the cables are not disturbed if either the main or auxiliary cover has to be removed. In the case of the flame-proof tank, the inlet in the tank cover is fitted with a flame-proof cable box specially designed to receive armoured cable. The starters can be combined with oil switches to form a complete motor control unit. Interlocks are fitted so that it is not possible to close the oil switch until the starter handle is in the "off" position.

The second leaflet to which we refer (Standard Specification X. 13) deals with horizontal oil-immersed drum type controllers. These are designed primarily for fiery mines, but at the same time will be found equally serviceable for the control of A.C. motors in steel works, dockyards, flour mills and similar situations where heavy demands are made upon starting gear. These units are made in three sizes for the control of motors from 60 h.p. to 120 h.p.

All the working parts are contained in a stout cast-iron case of minimum size. The drum is carried in end brackets which are bolted to the lid. Consequently, when the lid is opened the whole of the drum is dead, and adjustments can be made without fear of shock.

The drum consists of a square mild steel shaft on which micanite has been moulded, and a cast-iron hub with projections on which are fixed the moving con-

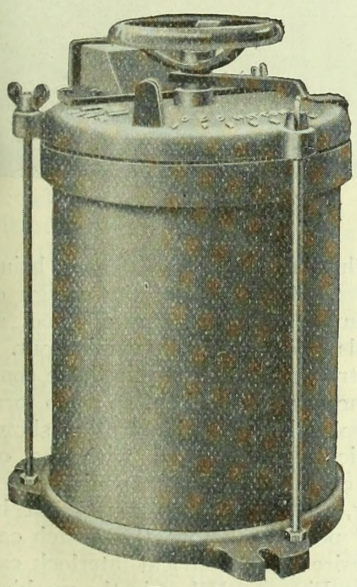


FIG. 1.

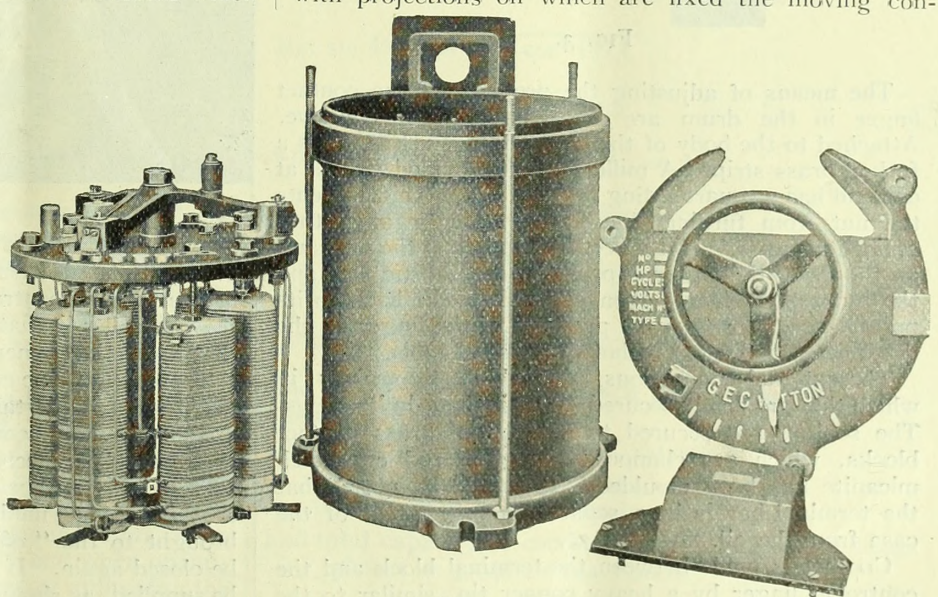


FIG. 2.

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tacts. The hub is split longitudinally and clamped on the steel shaft; it is also divided into suitable sections, so that the necessary control operations are made possible. The contacts are of hard drawn copper. Before they are mounted on the projection from the hub, the projections are machined so as to ensure a true circular motion.

The contact fingers are clamped to a mild steel square bar upon which is first moulded a layer of micanite. The bar is securely fixed to machined surfaces in the end brackets which carry the drum. The contact tip which makes contact with the drum is a half-round section of hard drawn copper, which is easily renewable when required. Current is carried from the cast-iron body of the finger to the copper tip by means of copper laminations; the current, therefore, does not pass through the spring which gives the necessary pressure to the copper tip. The clamping bolts securing these to the contact fingers are provided with spring washers so as to take up any compression that may occur in the micanised bar on which they are mounted.

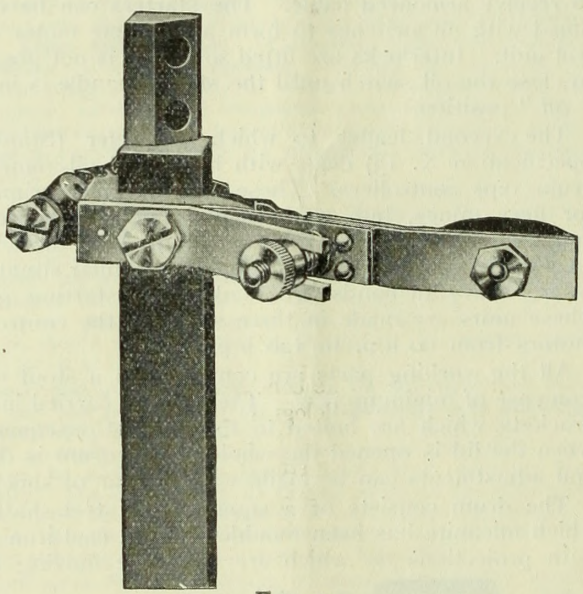


Fig. 3.

The means of adjusting the pressure of the contact finger in the drum are very simple and effective. Attached to the body of the contact finger (Fig. 3) is a forked brass strip. A milled nut is provided, which at one end has a square fitting into the slot. This prevents the nut from turning due to vibration or any other accidental cause. If it is required to adjust the pressure on the drum the finger is pressed back a little way and the nut adjusted, and then allowed to fall back to its normal position; thus the pressure of the finger on the drum can be adjusted without the use of tools.

The external connections are led in to sockets in which they are firmly secured by " pinching-in " screws. The sockets are secured to substantial brass contact blocks, which are clamped to a steel rod on which micanite has been moulded. It should be noted that the terminal bar is in a separate compartment of the case from the oil.

Contact is made between the terminal block and the controller finger by a heavy copper tip, similar to the tip of the contact finger. It is so arranged that when the lid is closed and screwed down the tip is pressed firmly on the terminal block. No flexibles are used in the design.

External connections are brought in at the bottom of the terminal compartment. Provision can be made for cable boxes, armoured clamps, or conduit. Inside sealing can also be arranged if desired, bitumen being filled in the terminal compartment for this purpose.

The operation is by means of a lever, the handle of which is at a comfortable working height. The lever is geared to the drum so as to obtain the necessary drum motion with ease, and to prevent oil leakage through the gland. Interlocking arrangements are provided, and particular attention is directed to the fact that, when the controller is in the " off " position, the motor is completely isolated from the line, all three phases being broken by the controller. A feature of the design of the controller is that ample clearances are allowed, so that inspection, renewals, etc., are easily carried out.

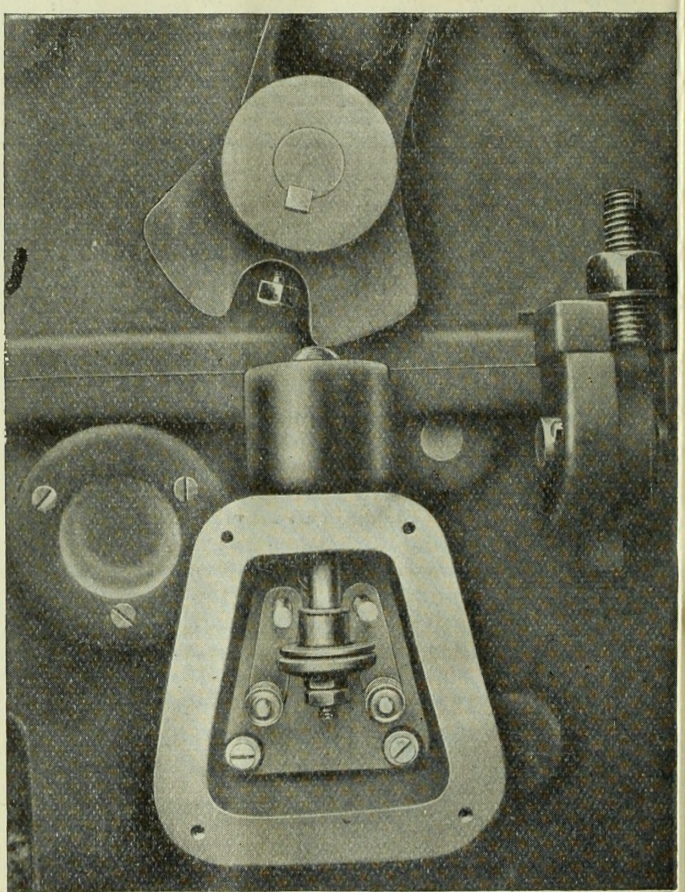


Fig. 4.

These drum-type controllers can, if required, be combined with a pedestal-mounted oil switch, so as to form a complete motor control unit. This illustration shows the controller mechanically interlocked with the oil switch. In the event of the oil switch opening when the motor is running, the controller must first be brought to the " off " position before the switch can be closed again. If desired, an electrical interlock can be supplied, as shown in Fig. 4. When in the working position, in either direction, the lever boss presses down

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on the spring plunger, as shown. Should the oil switch trip when running, it is necessary to bring the handle to the "off" position, when the plunger will rise to its full extent, and the disc make contact between the two pins which closes the no-volt circuit on the oil switch.

The leaflets on which this description is based contain, in addition to the information given above, full particulars as to sizes, ratings and other necessary details. Copies of either or both publications are obtainable from the G.E.C.'s head offices in Kingsway, or any of the branches.

ELECTRICAL ENGINEERING.—FINAL GRADE.

Solutions to 1922 Examination Questions of the City and Guilds Institute.

BY EDWARD HUGHES, B.Sc. (Eng.), A.M.I.E.E.

(*Continued from page* 207).

Q. 16.—Describe a type of condenser used to compensate for lagging current in a power supply system. A 2,000-volt, 50-cycle motor installation has a maximum load of 300 kVA at a power-factor of 0.6. Calculate the capacity of a condenser to raise the power-factor to 0.95 at maximum load. What will the power-factor be when the load is halved ?

A. 16.—The simplest and cheapest form of condenser for power-factor correction on comparatively small systems is the static condenser. One method of obtaining a large capacity without making the condenser unduly bulky, is to use tinfoil paper prepared by pasting very finely subdivided tin on one side of very thin paper, the coating being rendered electrically continuous by a calendering process. If two spirals of such paper be rolled up together, the films of tin will be separated by the paper. To enable the dielectric to withstand higher voltage, one or more layers of thin plain paper are interleaved between the strips of tinfoil paper. The rolled strips are thoroughly dried and then impregnated with paraffin wax.

Electrical connection to the tinfoil is made by means of very thin metal strips placed between the foiled surface and the interleaving paper, the coating of tin being so extremely fine that it is impossible to make a soldered connection to it.

Such condensers are made in elements of about one microfarad capacity, these elements being grouped to give the total capacity required and housed under oil in tanks. The working voltage of the type mostly used is about 600 volts ; so that when the supply is H.T., transformers have to be employed between the supply and the condensers.

Static condensers possess the important advantages of not requiring any attention and of wasting only a very small amount of power, the latter being about 0.5 per cent. of the input kVA for condensers of the above type when used without transformers.

It may be mentioned that synchronous motors, when over-excited, take a leading current ; and when operating on no load for the specific purpose of improving the power-factor, such machines are referred to as "synchronous condensers." They have the disadvantages of being generally more expensive than static condensers in first cost and of being more costly to operate owing to their greater losses and the necessity of at least some attention. Synchronous condensers possess the advantage, however, of assisting to correct the phase relationship between the line voltages, and have consequently been used in connection with power transmission over very long distances.

In calculating the required capacity of the condenser, it will be assumed that the current taken by the condenser leads by 90°. Also, since the load consists of motors, the system will be assumed three-phase.

$$\text{Current at P.F. of } 0.6 = \frac{300 \times 1{,}000}{1.73 \times 2{,}000} = 86.5$$

$$\text{and current at P.F. of } 0.95 = 86.5 \times \frac{0.6}{0.95} = 54.6$$

If OA and OB in Fig. 19 represent the currents taken

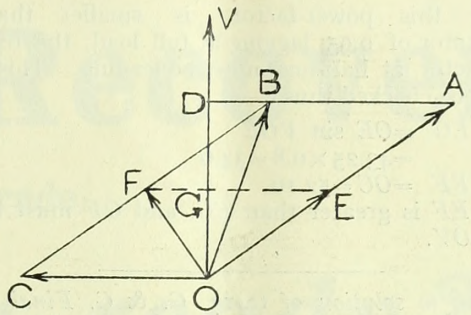


FIG. 19.

at power-factors of 0.6 and 0.95 respectively, and OC the current taken by the condenser, then OB must be the diagonal of the parallelogram formed by OA and OC. OV represents the phase voltage across the load should the latter be connected in star.

Produce AB to meet OV at D.

Then $OC = AB = AD - BD$

$= OA \sin VOA - OB \sin VOB.$

But $\sin VOA = \sqrt{1 - \cos^2 VOA}$

$= \sqrt{1 - (0.6)^2} = 0.8$

and $\sin VOB = \sqrt{1 - (0.95)^2} = 0.312$

$\therefore \quad OC = (86.5 \times 0.8) - (54.6 \times 0.312)$

$= 52.16$

= line current taken by condensers.

If condensers be connected in mesh, directly across the 2,000-volt lines, phase current $= \frac{52.16}{1.73} = 30.2$ amps,

and if C = capacity of each phase in farads,

then $I = 2\pi f C V$

i.e., $30.2 = 2 \times 3.14 \times 50 \times C \times 2{,}000$

$\therefore \quad C = 48.1 \times 10^{-6}$ farads

$= 48.1$ microfarads

and total capacity of condensers required for the three phases $= 3 \times 48.1 = 144.3$ mfds.

When the load is halved, the line current is 43.25 amps., and is represented by OE. But since the current taken by condensers is unaltered, the resultant current is

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represented by OF, the diagonal of the parallelogram formed by OE and OC, and the power-factor is given by cos FOV.

If G be the point of intersection of OV and EF, then

$$\cos FOV = \frac{OG}{OF}$$

But $OG = OE \cos VOE$
$= 43.25 \times 0.6 = 25.95$

and $OF^2 = OE^2 + OC^2 + 2OE \times OC \times \cos COE$
$= OE^2 + OC^2 - 2OE \times OC \times \sin VOE$
$= (43.25)^2 + (52.16)^2 - 2 \times 43.25 \times 52.16 \times$ [0.8
$= 980$

$\therefore \quad OF = 31.3$

and $\cos FOV = \frac{25.95}{31.3} = 0.828$

Since this power-factor is smaller than the power-factor of 0.95 lagging at full load, the resultant power-factor at half-load must be leading. This point can also be checked thus :—

$EG = OE \sin VOE$
$= 43.25 \times 0.8 = 34.6$

But $EF = OC = 52.16$

$\therefore$ EF is greater than EG, and OF must lead in front of OV.

Correction to solution of Q. 13, C. & G. Final Grade.

The latter part of this solution should read :

$$3\left(\frac{P}{\sqrt{3}+400\cos\phi}\right)^2 \times \frac{k}{A_1} = 2\left(\frac{P}{400}\right)^2 \times \frac{k}{A_2}$$

$$\therefore \quad \frac{3}{3\cos^2\phi} \times \frac{1}{A_1} = \frac{2}{A_2}$$

$$\therefore \quad \frac{A_2}{A_1} = 2\cos^2\phi.$$

. . . . . .

$$\therefore \quad \frac{\text{Weight of copper for A.C. system}}{\text{Weight of copper for D.C. system}} = \frac{3.5A_1}{2.5A_2}$$

$$= \frac{3.5}{2.5} \times \frac{1}{2\cos^2\phi} = \frac{0.7}{\cos^2\phi}$$

RATE OF SULPHATION OF STORAGE BATTERY PLATES.

An investigation has been undertaken by the U.S. Bureau of Standards to establish, if possible, a speedy and accurate method for the measurement of the effect of impurities in storage battery electrolytes. Methods which have previously been used require considerable time, and accurate and consistent results are difficult to obtain with them.

The new method which has been devised is based upon successive weighings of the positive or negative plates while immersed in the solutions to be tested, which are maintained at a constant temperature.

The battery plates were immersed in the various electrolytes contained within a thermostat bath and so arranged that any plate could be brought in the arm of a sensitive balance for weighing. Weighings of the plates were made daily, and the results were computed as the increase in weight of the plate per hour.

The results showed considerable differences in the rates of sulphation of plates made by various manufacturers, and marked differences in the rate of sulphation produced by different concentrations of the acid solution were demonstrated. Temperature also plays an important part in determining the rate of sulphation. —*Telephony* (Chicago.)

Correspondence.

THE W. E. HIGHFIELD SHIELD.

To the Editor of Electricity.

Sir,—In continuation of our letter of March 29, in which preliminary notice was given regarding the decision of the Board of Control to award prizes for educational papers by members, the following conditions governing the competition were approved at the members' meeting on the 12th inst. :—

(1) All entries and papers addressed to the General Secretary must be received at the Head Office not later than Monday, April 30, 1923.
(2) Subjects of papers must refer to the electrical industry and/or the Association.
(3) All papers will be typed out by head office, and each paper given a number.
(4) The typed copies will be read at the meeting on May 8 next by selected members of the B.O.C. or others, so that the identity of the writers will not be known.
(5) Those present at the meeting on May 8 will vote by putting a cross (×) opposite the number of the papers which they think best.
(6) Papers sent in will be kept in the possession of the General Secretary, and the names of the writers will not be known until after the ballot decision has been declared.
(7) A signed declaration that the paper is the unaided work of the competitor must accompany each paper.

The above conditions should make for fair judging.

It was decided by the members' meeting to call the Shield, which has been presented by the president, the W. E. Highfield Shield, a slight recognition of Mr. Highfield's interest in the work of the Association.

Three valuable prizes are also being given for the first, second and third winners. The winner of the first prize will be entitled to hold the Shield for one year, and his name will be suitably inscribed thereon.

The object of the scheme is to encourage papers of a practical nature and original thought, and these will receive first consideration in judging. *The literary excellence is of minor importance.*

A number of entries and papers have already been received, and readers of Electricity are asked to remember that the last date for receiving papers and entries is April 30, 1923.

The Shield may be viewed at the registered office of the N.A.S.E.

Yours faithfully,
F. T. Alldread, Chairman.
A. Brammer, General Secretary.
(Nat. Ass. Supervising Electricians.)

82, Victoria Street, London, S.W.1.
April 18, 1923.

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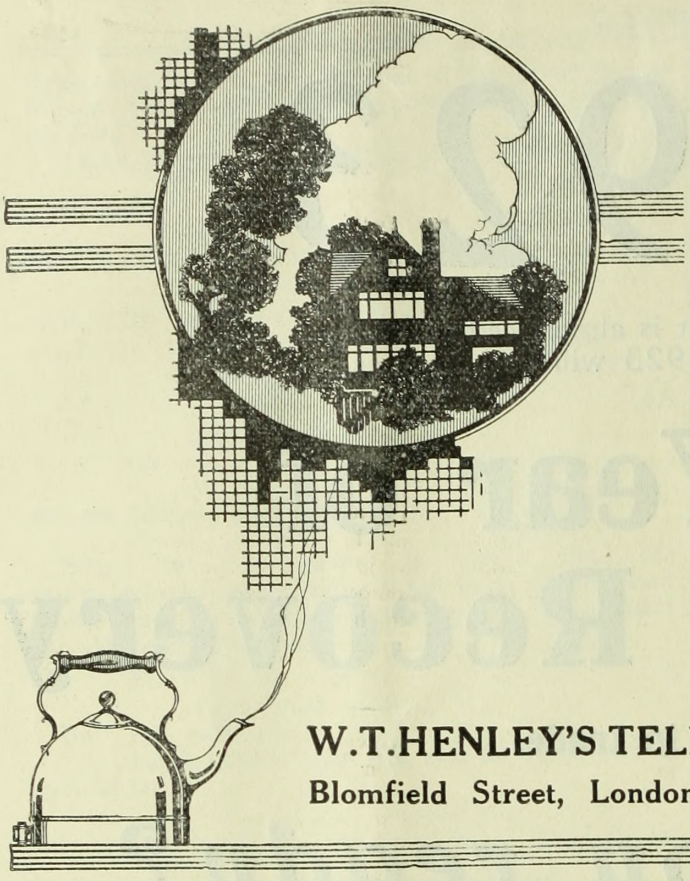
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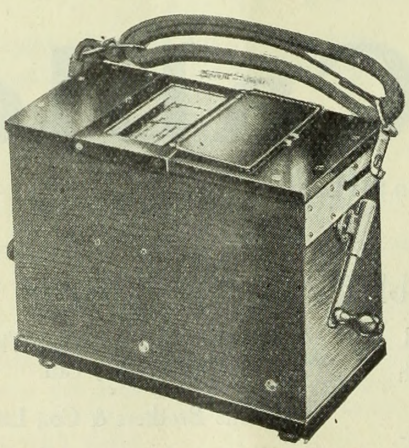
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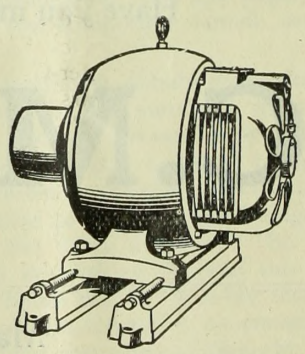
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TO OUR READERS.

ELECTRICITY is published every Friday, and, if ordered, is on sale at the principal Railway Station Bookstalls and Newsagents on that day. It has a very large sale throughout the United Kingdom, as well as in the British Colonies and Abroad.

New advertisements for the displayed columns and alterations to existing ones must reach the publishing office not later than first post Tuesday morning, in order to be in time for the issue of the following Friday. This is important. Rate quoted on application. Subscription: 13s. a year, 6s. 6d. half year, 3s. 3d. a quarter in advance, postage prepaid in the United Kingdom and abroad.

Questions to which an answer is required must be accompanied by a 1½d. stamp for reply. When considered of sufficient interest, the answer will probably appear in the paper.

All remittances payable to the Publishers, S. RENTELL AND CO., LTD., 36-39, Maiden Lane, London, W.C.2. Telephone No. 2460 Gerrard.

Current Topics.

The Broadcasting Fiasco.

The long drawn-out wrangle between all the principal parties interested in the future of broadcasting is not a very good object lesson on how to conduct what is in effect a national enterprise. It would appear from the divergent and conflicting interests that a strong man is wanted to pull the chestnuts out of the fire unless broadcasting is to be allowed to die a natural death. There was quite enough haggling and delay over the original scheme, long before the public were given what they had been promised for so long, and, now that the actual broadcasting entertainments have been running for one winter only, another complication has arisen over the vexed question of "constructor's licences" for those ambitious people who desire to build their own sets at home and enjoy the additional pride of having created a practical receiving set with their own hands.

There is no radical objection to this course, and the Postmaster-General has apparently agreed to issue such licences at the very nominal fee of ten shillings, half of which would be handed over to the Broadcasting Company as a contribution towards the cost of providing the entertainments. In view of the original undertaking by a former Postmaster-General to protect British trade for at least two years from the commencement of broadcasting, however, the Broadcasting Company stipulate that essential components purchased under such a constructor's licence should bear the B.B.C. stamp and be subject to a very nominal royalty, also towards the cost of the entertainments, which cannot be carried on without adequate financial support.

Certain firms interested in the importation of German and other Continental and American wireless apparatus, together with the smaller manufacturers who have no financial stake in the new hobby, take exception to this proviso, and they are very naturally backed by the various radio societies, who, human nature being what it is, are out to secure the cheapest possible market for their large membership. In the circumstances, unless it is made incumbent upon manufacturers and suppliers of components to stamp their goods "B.B.C.," it is self-evident that there will be an immediate and considerable dumping of cheap foreign wireless components into this country, to the detriment not only of the British manufacturers of such goods, but also to the broadcasting movement as a whole, since the Broadcasting Company will be deprived of sufficient revenue for providing adequate and acceptable entertainments.

Whilst sympathising with the popular ideal of cheaper receiving sets, one cannot divorce this ideal from the necessity for finding the money for the entertainments. Virtually what the sponsors of unstamped components are asking for is freedom to import cheap and nasty goods, coupled with the ability to enjoy free entertainment for 365 days in the year if they so wish. Five shillings a head from the public who take out constructors' licences obviously won't go far towards entertainments broadcasted daily from half a dozen transmitting stations spread about the British Isles, each with its costly plant and skilled technical staff, to to say nothing of the artistes who are engaged to sing, play and recite. We have been somewhat drastically criticised by our American contemporaries on the way we have mismanaged our broadcasting venture, and, if the P.M.G. adheres to his policy of allowing free and unrestricted trade in components, we look like qualifying for the criticism which has already been levelled at us, together with an equally chaotic state of the ether to that alleged to prevail in U.S.A.

Watch the Profiteers.

Little signs are not wanting that the purchasing public must still be on the *qui vive* against the profiteer, who, profiting by the lull in Press publicity, is again putting up the retail prices of certain essential commodities. Thus, the publication of the Budget and the passing over of sugar in the matter of relief from taxation has been made an excuse for raising the price of this staple food, although there is no logical excuse for this action on the part of the trade. Again, I heard a rumour to-day that galvanised ware, together with certain kinds of soap, are to have a penny or two tacked on to the present retail prices. The moral to shopping housewives is: Watch prices, and deal only with those establishments which mark their goods and sell at current rates. In the case of a general increase, buy as little as possible of the particular commodity affected. It is wonderful what a co-operative boycott will effect in the way of checking profiteers.

Miners' Lamps: A Strong Prejudice.

Verily we are a strongly conservative race, and it takes generations to overcome some of our pet theories. Only a few weeks ago we had the experience of a lecturer preaching against the evils of incandescent electric and even gas lighting, and beseeching us to revert to the wax candles and tallow dips of our forefathers if we valued our eyesight. Similarly, among mining experts there is still considerable prejudice in favour of the old-fashioned Davy safety lamp, which has admittedly done good service in British coal mines for many years, but suffers from the disadvantage that its standard of maximum illumination is of a very low order. Within the past decade considerable progress has been made in the design and development of electric lamps for miners, which have a higher standard of illumination, and are equally as safe, if not safer, in gaseous atmospheres than the oil lamp which they displace.

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One objection to the electric as against the oil lamp is that, to every experienced miner, the latter constitutes an ever-present warning against the presence of firedamp, the nature of the flame giving instant indication of danger from this gas. The electric lamp does not possess this property, but, on the other hand, appropriate and very sensitive apparatus has been produced and is available for close detection of firedamp and other dangerous gases, and there is no excuse for its absence where such safeguards are rendered necessary by the nature of the pit in which coal is being hewn.

As if this objection to progressive development were insufficient, we now have so high an authority on mining matters as Sir Henry Hall advancing the theory that a better light is not required for coal getting, and that miners' nystagmus is probably not attributable to eye-strain at all, but rather to volatile gases given off by certain grades of coal. Whilst one bows to Sir Henry's superior wisdom and experience of coal mining, one can scarcely concede that the occupation of coal mining can be conducted under too high a standard of illumination. We all know how trying to the eyes any dark background can be under artificial illumination, as witness the housewife darning stockings by gas or electric light. There is scarcely any known substance blacker than coal and, for men who spend all their working hours at the coal face surely the best possible artificial illumination, short of glare, is the least we can provide them with.

Elektron.

TELEGRAPHY.*

Being Solutions to the Questions set by the City and Guilds of London Institute at the Final Grade Examination in Telegraphy held in May, 1922.

Compiled by a Silver Medallist.

(*Concluded from page 208*)

Q. 9.—Explain with diagrams the principle of Baudot multiplex working.

A.—The Baudot is a multiplex type-printing telegraph system based upon the use of a 5-unit code for the alphabet. The signals representing a letter are sent to the line by means of a manually operated keyboard working in conjunction with a distributor, which latter consists of a number of concentric metallic rings, traversed by rotating brushes. At the distant station the incoming line currents operate a polarised relay which delivers through the medium of another distributor the current impulses to a receiver; the latter translates the impulses and prints the message in block letter capitals upon a blue slip of paper. In the Baudot code the various letters are made up of combinations of positive and negative current impulses, each letter consisting of a different combination, but occupying the same time in line transmission. The number of impulses per letter, whether negative or positive, or a combination of both, is five.

Distributors are employed, one at each end of the line, to enable the multiplex principle of giving a number of operators successively the use of a telegraph line alone for a short time during recurring periods to be used. Fig. 2 shows the principle of the Baudot system. For the sake of simplicity only two arms sub-divided into five segments are shown at each end. The segments are insulated from each other. At the station *B* the segments of one arm are shown connected to the contact levers of a sending instrument, which are operated by five keys and constitute the keyboard of one operator. At *A* the segments are connected to a set of five electromagnets which form with other mechanism one receiving instrument. The polarised relay is necessary at *A* because the electromagnets of a receiver being non-polarised would be operated by both positive and negative currents, and it would not be possible to operate them selectively if they were connected direct to the line. The two brush arms are assumed to be running in phase, that is, they are revolving at the same uniform rate and occupying the same relative positions revolution after revolution. The depression of any key of the keyboard simply determines that a marking current (i.e., negative) shall be sent from that particular key. Thus if 2 and 5 be depressed a spacing current will be sent from 1, marking from 2, spacing from 3 and 4, and marking from 5. At *A* the relay tongue moves to marking in response to currents 2 and 5, and to spacing in response to 1, 3 and 4. Numbers 2 and 5 electromagnets will therefore be actuated by the currents sent from the local battery joined to the marking contact of the relay.

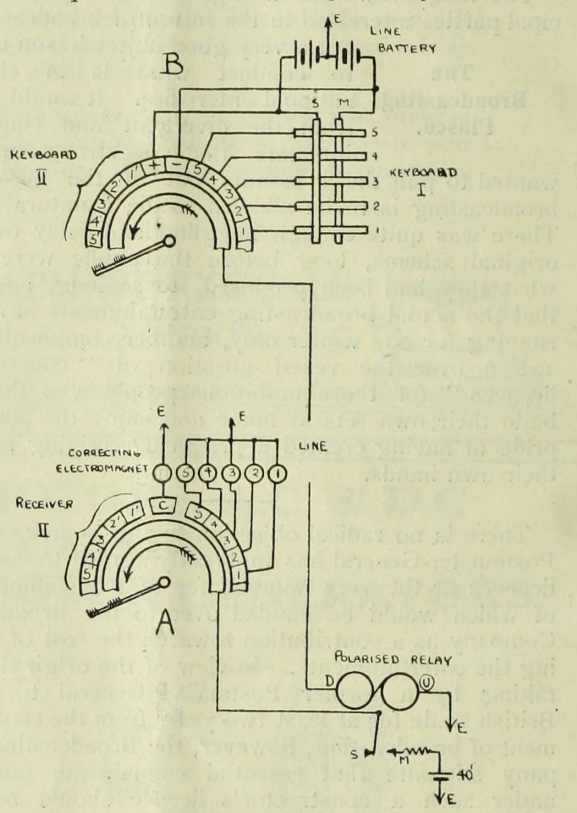


Fig. 2.

In order that the keys may be operated at the right time, i.e., just before the brush reaches the segments allocated to a particular keyboard, a cadence signal is provided in order to warn the operator. This is

* Consult also "Questions and Solutions in Telegraphy and Telephony," Final Grade, by Few, 2s. 3d. post free from Electricity Office.

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given by the tapping of the armature of an electromagnet worked from a contact on the distributor, placed inside the keyboard. In addition to warning the operators when to depress the keys, it is also necessary to prevent them from allowing the keys to rise before the brush has passed over the corresponding segments. This is ensured by a mechanical locking device which releases the depressed keys when current passes through the cadence electromagnet.

Phase relationship is maintained between the brushes at the two stations by using two segments on the sending ring at the "correcting station" *B* for sending a correcting signal, which consists of a negative current followed by a positive. The brush arm at the station *B* is set to run at a speed of 180 revolutions per min., which is equivalent to a speed of 30 words per min.; while that at the "corrected station" *A* is arranged to run slightly faster, usually about 180½ revolutions per min. The relative positions of the positive and negative correcting segments at *B* and the correcting segment *C* at *A* are such that if the brush at *B* is on the positive segment and that at *A* is on *C*, then the two brush arms are in phase. If, however, the brush at *B* is on the negative segment when that at *A* is on *C*, which is bound to happen sooner or later, since *A* is "running" faster than *B*, then the brush arm at *A* is in advance of that at *B*. Now in this latter case the tongue of the polarised relay at *A* is on the marking stop, because *B* is sending a negative current which *B* is "marking," hence the correcting electromagnet connected to segment *C* will be operated. The resulting movement of the armature of the correcting electromagnet acts on the driving mechanism of the distributor brushes and momentarily uncouples the brush arm from the driving mechanism so that the phase relationship of the brushes is restored.

It is necessary, of course, that the brushes should rotate at a uniform rate; two methods are in use for driving the spindle which carries the brush-holders. In the first and older method the necessary energy required is furnished by a falling weight. Theoretically this should give a constant speed to the brushes, but it is necessary in practice to provide a centrifugal governor to prevent fluctuations due to variations in the frictional resistances in the driving mechanism, otherwise satisfactory multiplex working would be impracticable. The second method, which is superseding the weight drive, consists in using a vibrating reed and phonic wheel motor directly coupled to the brush axle. The phonic wheel motor is specially constructed to prevent speed oscillations and a governor is not necessary.

Q. 10.—Describe with a diagram the principle of a double current duplex repeater.

A.—The skeleton connections for duplex repeater working are shown in Fig. 3.

The local circuits, the keys, leaks, etc., have been omitted for the sake of clearness, and the four compensation circuits have been denoted by *R*. The batteries are shown connected with the keys at rest, and it is assumed that the circuits have been balanced for resistance and capacity, as in ordinary duplex working.

When the keys are at rest, the path of the current is from the positive pole of the down office battery, through the *D* circle, *U* circle coil of the down office relay, down line, *D* to *U* coil of the down side transmitting relay, *T* terminal of the up side transmitting relay, via the tongue, left half of the battery to earth, in at the right coil of the down office galvanometer to the negative pole of the battery. The path of the current in the down side compensation circuit is from the positive pole of the left half of the up side battery, through the down side compensation circuit, circle coil of the down side relay (direction *U* to *D*), to *T* of the up side relay, via the tongue and spacing contact to the negative pole of the battery. Thus, with the keys at rest, the down

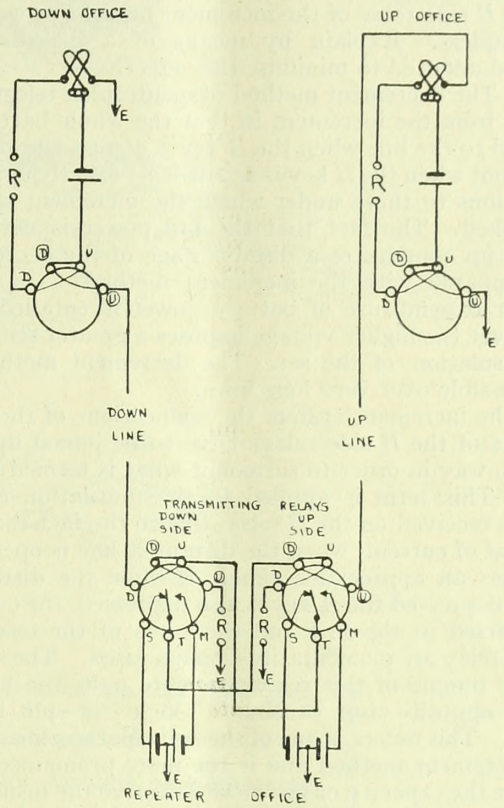


FIG. 3.

office battery and the up side battery combine to produce a current in the plain coils of the down side relay (direction *D* to *U*) twice the value of that in the circle coils of the down side relay (direction *U* to *D*); the tongue of the down side relay is therefore held against the spacing stop.

Similar remarks apply to the up side relay which spaces under like conditions.

When the key at the down office is depressed, the down office battery is reversed and opposes the up side battery; no current therefore flows in the plain coils of the down side relay. The current from the up side battery, however, flows through the down side compensation circuit, through the *U* circle, *D* circle coils of the down side relay, and causes a mark.

Similar remarks apply when the up office key is depressed.

When both keys are simultaneously depressed the current is everywhere reversed in direction, and the line currents being stronger than the spacing compensation currents, cause the relays to mark.

Thus the relays at the repeater office take the place of the keys and transmit the signals to the terminal stations in the same way as if the receiving apparatus were connected directly in the same circuit as the keys.

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A Wheatstone receiver in "leak" and a switch are provided so that the repeater clerk may check the signals passing through the repeating apparatus to the terminal stations. Sounders and signalling keys are also provided to enable communications to take place with the terminal stations whenever necessary.

Q. 11.—What are the relative advantages of the increment and decrement methods of working quadruplex telegraphy? What is the cause of split signals on the *B* side relay of the increment method of working quadruplex? Explain by means of a diagram the method adopted to minimise this effect.

A.—The decrement method of quadruplex telegraphy differs from the increment in that the whole battery is applied to the line when the *B* key is at rest and part of it cut out when the *B* key is depressed—exactly opposite conditions to those under which the increment system is worked. The fact that the full power is normally joined up constitutes a disadvantage of the decrement as compared with the increment method, as a much greater expenditure of battery power is entailed, and moreover the higher voltage imposes a greater strain on the insulation of the set. The decrement method is not possible over very long lines.

In the increment system the connections of the local circuits of the *B* side relays have to be joined up in a certain way in order to surmount what is termed the *B* kick. This term is applied to the mutilation of the signals received on the *B* relay, due to the fact that the reversal of current, when the distant *A* key is operated, occupies an appreciable time. If while the distant *B* key is depressed the *A* key is also depressed, the current is reversed in the line and the cores of the receiving *B* side relay are momentarily demagnetised. The spring on the tongue of this relay therefore pulls the tongue to the opposite stop, causing a "kick" or split in the signal. This defect is one of the principal weaknesses of the increment method and is the more pronounced the greater the capacity or the more defective the insulation of the line. It may also be due to a badly adjusted key, that is, a key which, when its lever is in the intermediate position, either does not short circuit the battery at all, or short circuits it for too long a period. The method adopted for connecting the apparatus in the local circuit of the *B* side relay in order to minimise the effect of the *B* kick is shown in Fig. 4.

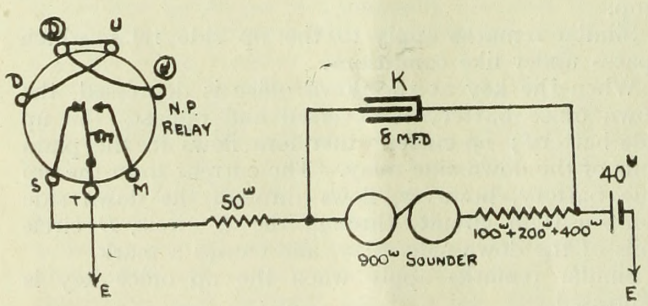


Fig. 4.

The function of the condenser *K* is to bridge the breaks which would otherwise occur in the received signals. Suppose that at the moment a *dash* is being registered the *A* key at the sending end be depressed. The cores of the *B* side relay at the receiving end will be momentarily demagnetised, the spring will act, and the tongue will move away from the spacing stop. The condenser is already charged by the local battery of 40 volts, and when the momentary break of the local circuit occurs, it discharges through the sounder and the adjustable resistance, thus prolonging the magnetisation of the cores of the sounder and preventing the break in the continuity of the signal. The 50 ohm resistance coil is inserted between the sounder and the spacing terminal of the relay in order to prevent welding at the contacts which might otherwise result from the heavy rushes of current into the condenser.

One advantage of the decrement system is that the foregoing arrangement is not necessary as the *B* side relay marks when the battery power is diminished, and as the reversal of the current by the *A* key does not increase the value of the current, such reversal cannot have any effect towards causing the tongue of the *B* side relay to leave the marking contact and so break the signal. A reversal of the current when the tongue of the *B* side relay is on the spacing contact does not cause a false signal, if proper adjustments have been made, because the time during which the current is below the "spacing" value is not sufficient to enable the spring to pull the tongue over completely to the marking contact; and, as the stop against which the tongue is resting when the reversal takes place is not a working contact, the fact that the tongue leaves this contact does not matter so long as the marking contact stop is not touched.

Q. 12.—A battery of 6 volts electromotive force and 2 ohms internal resistance is connected to a 4-ohm external resistance. What will be the potential difference measured across the terminals of the battery? If a second battery of 3 volts electromotive force and 3 ohms resistance is joined in parallel with the first battery with similar poles connected together, the external resistance remaining connected thereto, what will then be the potential difference measured across the terminals of the battery?

A.—In the first part of the question, by Ohm's Law the current in the circuit is

$$\frac{\text{E.M.F.}}{\text{Total Resistance}} = \frac{6}{2+4} = 1 \text{ ampere.}$$

The potential difference across the battery terminals is equal to the current multiplied by the external resistance and is therefore equal to

$$1 \times 4 = 4 \text{ volts.}$$

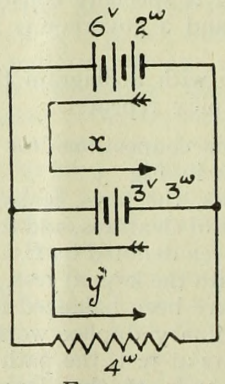


Fig. 5.

For the second part of the question recourse must be had to Kirchhoff's Laws. Referring to Fig. 5, which

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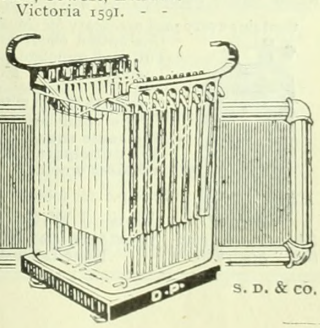
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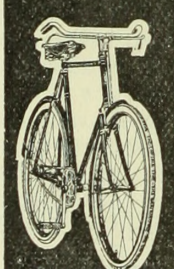
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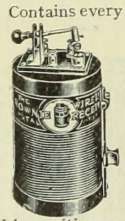


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represents the conditions, suppose currents x and y circulate the meshes as indicated.

Applying Kirchhoff's 2nd Law to the upper mesh we have

$$2x + 3x - 3y = 6 - 3$$
$$\text{or } 5x - 3y = 3 \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

Similarly for the lower mesh

$$3y + 4y - 3x = 3$$
$$\text{or } -3x + 7y = 3 \quad . \quad . \quad . \quad . \quad . \quad (2)$$

Solving (1) and (2) for y we obtain

$$y = \frac{12}{13} \text{ amp.}$$

But y is the current in the external circuit, therefore, as before, the potential difference across terminals of the 6 volt battery is equal to

$$\frac{12}{13} \times 4 = \frac{48}{13} = 3.69 \text{ volts.}$$

USE OF STATIC CONDENSERS FOR POWER FACTOR IMPROVEMENT.

(*Concluded from page* 201.)

How Should Condensers be Installed?—As already noted it is only necessary to connect the correcting condenser in parallel with the stator of the motor whose power factor is to be improved. The question arises however: Should the condenser be switched in and out of circuit with the motor, or should it be left in circuit so as to exert permanently an anti-reactive effect? Obviously, if there were too many condensers permanently on the mains, the resultant current in the network would be leading, and this would be as objectionable as lagging wattless current. The lagging component in existing networks is, however, so considerable that condensers would have to be used very much more extensively than is at present the case before this risk became serious. Nevertheless, says M. Varret, French supply companies prefer to have condensers disconnected simultaneously with the motors to which they are applied, and, in order to avoid abuse of the condensers, the companies favour the fitting of ratchets to the reactive power meters so that the latter can never run backwards. In other words, the consumer is not allowed credit for any leading wattless current. This policy would be justifiable if the consumer could take lagging current for some time, and then wipe the record thereof from the meter by taking idle leading current, but it seems to us that, in practice, a consumer who had installed condensers in a suitable manner could never take a serious lagging current, whilst on the other hand he might reasonably be considered entitled to some rebate in respect of leading current "produced" by his condensers when his motors were idle. This, however, is a question depending upon the circumstances of individual cases, and does not affect the broad principle of power-factor correction by aid of condensers. Neither does it affect seriously the advantage of such compensation to the consumer and the supply authority. In the meantime, to allow credit to consumers for leading current would offer an incentive to install condensers.

It is recommended that the condensers should be mounted near the motor starter. They should not be placed on the motor or in its baseplate because heat and vibration deteriorate static condensers. Hitherto, in France small condensers have been connected directly, and large condensers have been controlled by special switches fitted with resistances, and interlocked with the starting resistance. The use of resistances in conjunction with the condensers can be avoided by modifying the starting switch so that the condenser is switched into circuit section by section, each of the sections being of such capacity that no dangerous pressure rise occurs during switching. Fig. 4 illustrates a switch designed for such service; it will be seen that the condenser can be divided into $2n - 1$ sections by a switch with n pairs of contacts per phase. As the switch is brought down into its lower position, it automatically places in circuit consecutive sections of the condenser. In most cases, this renders resistances unnecessary.

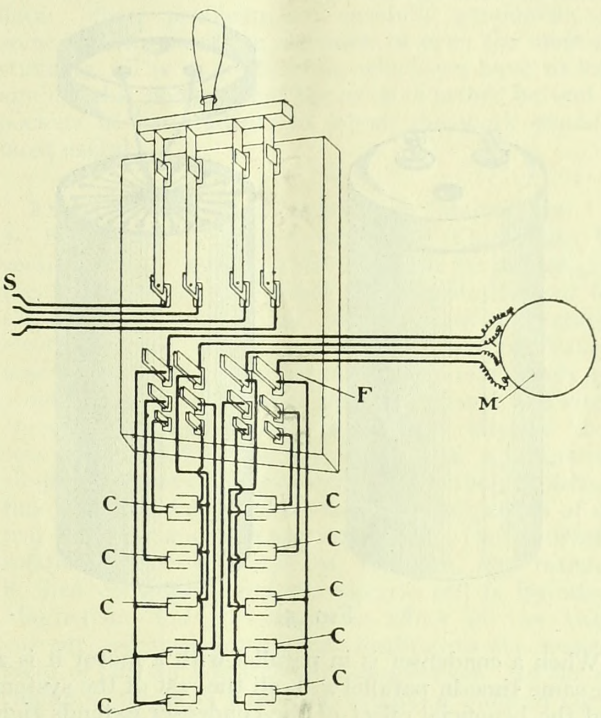


FIG. 4.

Construction of Condensers.—Fig. 5 shows the external features of the Varret condensers as built for industrial service in power factor improvement. The condenser plates are wound cylindrically from long strips, so that a condenser of, say, 100 mfd. capacity can be built in a single operation. In order that a breakdown may not render useless the whole condenser, the latter is arranged in a number of independent sections interconnected by fuses as shown in Fig. 5, so that in the event of a fault occurring the defective section is isolated immediately. If the condenser consists originally of 100 sections of 1 mfd. each, and if the pressure applied be raised gradually until one section breaks down (at, say, 800 volts), we have then a condenser of 99 mfd., which, it has been proved, will withstand 800 volts. The sectionalised construction makes possible a great variety of combinations—*e.g.*, graduated condensers, polyphase condensers,

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and condensers adjusted to exactly the desired capacity. Additional sections may be provided, so that by leaving some of them unconnected a reserve of capacity is obtained and any desired capacity smaller than the total can be obtained. Standard condensers of the type illustrated are in units of 25 mfd., each being in a solid sheet case, 230 mm. high and 105 mm. in diameter. Condensers for service on 220 volt circuits are tested to 600 volts.

General Notes.—In conclusion, mention may be made of a few facts of general interest in connection with the use of condensers for power factor improvement. With a capacity connected in parallel with an inductive circuit, "current resonance" is obtained when the anti-reactive current equals the reactive current. The current to be interrupted at the main switch is then a minimum and, since the inductance is completely compensated by the capacity, there is no arcing at the switch; the circuit is, in fact, from this point of view composed simply of non-inductive resistance.

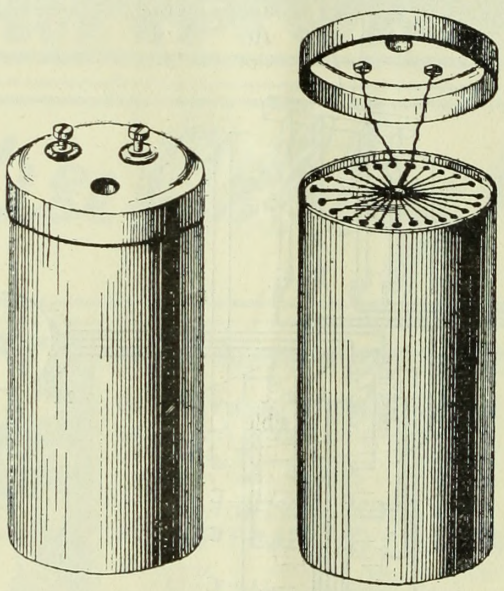


Fig. 5.

When a condenser is in parallel with a motor it is at the same time in parallel with all the rest of the system, and the beneficial effect of the condenser extends right back to the generator—even though there be transformers between the consumer and the central station.

It is often thought that condensers used for power factor correction in two- or three-phase circuits must be balanced accurately. This is not the case; reasonably close balance is naturally desirable, but the motor will operate quite satisfactorily even if the condenser be removed from one phase. A good deal of confusion has been caused by the practice of calling the leading current component introduced by the condenser a "demagnetising" current. This is in distinction from the lagging "magnetising" current of the motor, but actually the condenser and the motor currents combine *outside* the motor, and the condenser current does not demagnetise any part of the motor. The current in the motor itself at a given load remains the same whatever the capacity connected across the motor terminals. It is on the supply side of the condenser that the corrective effect of the latter becomes obvious.

The only cost of operating a static condenser installation is the standing charge on the capital cost of the apparatus. There is no running cost in the ordinary sense of the term.

Questions and Answers by Practical Men.

RULES.

Questions: *We invite our readers to send us questions, preferably on technical problems that have arisen in actual practice. Questions which we consider of sufficient interest to our readers will either be replied to under "Answers to Correspondents" or replies will be invited from our readers. One shilling will be paid for the question which we select for competitive replies in this column.*

Answers: *A fee of 10s. will be paid for the answer which we consider shows the greatest merit, and 5s. for the one we select as second best. In judging the replies, importance will be attached to clearness and conciseness, as well as accuracy. The Editor reserves the right to make no award, or to accept only one reply, if, in his opinion, the answers received do not possess sufficient merit. Competitors desiring the return of their manuscripts, if unaccepted, should enclose stamped addressed envelope.*

Write on one side of the paper only, and if diagrams are sent, draw them on a separate sheet of paper attached to the manuscript. Competitors may adopt a "nom de plume," but, both in the case of questions and answers, the competitor's real name and address must be sent with the manuscript as a guarantee of good faith. No correspondence will be entered into with regard to successful replies. The Editor's decision is final.

Commencing with Question No. 101, a Diploma of Merit will be awarded to the six competitors who win the first or second prize the most times during the next twelve months.

The words "Questions and Answers" or "Q" and "A" should be placed at the top left-hand corner of all letters intended for this column.

Question No. 157.

Can any reader give me details from which I can make a Nodon Valve to enable me to charge accumulators from an A.C. supply? What is the action of such a valve?—"Wireless."

Question No. 158.

I have to repair a number of accumulators. My difficulty is that I do not know how to connect the bridge pieces, that is, the bars which are connected across the top of each set of plates. I understand that these are "burnt" on. How is this done?—"Accumulator."

(*Replies to Questions 157 and 158 must be received not later than April 28, 1923.*)

THE ENGINE OF THE SMALL GENERATING SET.

At the Birmingham and District Electric Club recently, Mr. E. Cauldwell, A.M.I.A.E., gave a lecture on "The Engine of the Small Generating Set," in which he analysed the problem presented to the designer of internal combustion engines, using the Otto cycle and suitable driving generators up to 6 kw. The lecturer dealt especially with engine efficiency as conditioned by mechanical design, engine speed and fuel properties. The difficulties of obtaining ideal efficiencies were treated at length. The paper was highly technical and gave much evidence of individual research. It was illustrated by a large number of graphs and formulæ.

The Institution of Welding Engineers.—We notice from the latest issue of the *Acetylene Welding Journal* that the Institution of Welding Engineers has been formed and is now enrolling members. The first President is Sir W. P. Rylands, and the Vice-Presidents are Sir Robert Hadfield, Bt., Prof. S. C. Thompson and Mr. Charles Bingham. The Institution appeals to a very wide class; in fact, to all who are interested in engineering and the joining of metals generally, and as welding has now assumed such a very important position in the electrical industry, we are confident that it will interest a very large number of our readers. Full particulars and application forms may be obtained on application to the Secretary, Mr. C. Raggett, at 30, Red Lion Square, London, W.C.1.

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Reviews of Books, &c.

[Books noticed in this column will be sent from Electricity *Office to any part of the world, for the published price, plus ten per cent. for postage (minimum 2d.) and orders will be appreciated.]*

The Journal of the Institute of Metals, Vol. XXVIII. Pp. lx. plus 1,010, with 37 plates and numerous figs. Edited by G. Shaw Scott, M.Sc. (Institute of Metals, 36-38, Victoria Street, S.W.1. Price 31s. 6d. net.)—The ever growing Journal of the Institute of Metals has now become a very substantial volume, the latest issue containing several hundred pages more than any previous volume. The increase in size is due to three causes, viz.: The large number of papers contained in Section I., which consists of the official minutes of proceedings of the Institute and covers five hundred pages; the greatly enlarged Section II., which embodies over four hundred pages of abstracts of metallurgical and allied papers published throughout the world; and the very full index, which contains over five thousand entries, a fact which alone gives an idea of the comprehensive character of the new journal. The seventeen papers reproduced in the volume under notice deal with a large number of metals and alloys. They include not only all those that were presented at the recent Swansea meeting of the Institute, but also Sir Ernest Rutherford's May Lecture on "The Relation of the Elements," and Dr. R. S. Hutton's Autumn Lecture on "The Science of Human Effort (Motion Study and Vocational Training)." A valuable new feature to be noted in Section II. is a detailed list of many hundreds of the world's metallurgical and allied periodicals. The publisher's name and address are given for each of these periodicals, together with the price and date of publication. A list of such completeness has not hitherto been available, and metallurgical workers should find it invaluable. Incidentally, it might be remarked that all these hundreds of papers are regularly searched by the Institute's staff of abstractors, the result of whose work is embodied in Section II. of the Journal, making this very much more complete and full than has previously been the case. It may well be wondered how such a fine volume can be supplied at the price, and, further, how it is possible for the members of the Institute to be able to obtain two of these volumes in each year for a purely nominal subscription. We can but congratulate the members on the bargain they are getting (as a result of which, no doubt, there will be a considerable increase in the membership of the Institute), and the Editor upon the highly creditable manner in which this remarkable Journal is produced.

Principles of Electrical Engineering. By W. H. Timbie and V. Bush. 513 pp., 224 figs. (Chapman and Hall. 20s. net.)—So well known and so excellent are the other books in which Prof. Timbie is part author that the fact that he is associated with the book now before us is a sufficient guarantee of its excellence. The aim of the work is to provide a substantial first course in the subject by presenting rigorously and in understandable form the really basic principles upon which modern electrical engineering rests. Many problems and examples of current engineering practice are introduced. The book is not a condensed treatise on the whole subject, but is strictly a first course, and its study should be followed by detailed courses in direct current and alternating current machinery. The special features of the volume may be thus summarised: (1) The subject of the magnetic circuit receives the prominence and detailed treatment to which it is undoubtedly entitled by reason of its importance in modern electrical engineering. (2) The electron theory is freely used as a basis for explanation. (3) The subjects of thermionic emission, conduction through gases, electrolytic conduction and certain high frequency phenomena have been included. (4) The behaviour of dielectrics have been approached from a standpoint which departs from the historical method in order to gain clearness and unity of treatment. (5) About 500 problems are included for illustration, for practice in applying the principles, and for the purpose of bringing before the student useful and interesting engineering data. These problems are carefully graduated, and some of them merit the attention of even the most able students. The only objection which we have to lodge against this book is that the price is rather beyond the pockets of the students to whom the work would be most useful.

Experimental Electricity and Magnetism. By S. E. Brown. 222 pp. 193 figs. (Cambridge University Press. 5s. net.)—In this book the author gives the student from the outset the benefits derived from the recent advance in our knowledge of the nature of electricity. By realising the properties of Nature's unit—the electron—the beginner can undoubtedly gain a more vivid conception of electric pressure and electric current than was possible before the electron theory was formulated. Commencing with an admirably simple explanation of electrons, the author explains on this basis the fundamental laws and properties of electric charges and electric current. The hydrostatic relationship between current, pressure, and resistance is then considered and the electric cell is introduced. Magnetism and the magnetic effect of the electric current are then considered, leading to the measurement of current and theory of magnetism. In the next chapters, the laws and applications of induced current and the electrolytic effect of the electric current are discussed. Applications of Ohm's law then follow, and by this time the student is in a position to appreciate properly the matter on units and definitions. Potential, capacity, condensers and influence machines then receive treatment, and it is worth noting that these subjects, which commonly form the introduction to "elementary" books on electricity and magnetism, are here brought to the notice of the student at a much later stage in his studies. The remainder of the book is devoted to the generation and practical application of electricity and to such modern branches of science as X-rays, radio-activity, and wireless telegraphy and telephony.

The matriculation syllabus is covered fully by this volume and practical work is carried to the standard of the Higher School Certificate. Needless to say, the production of the work is excellent all through, and the price is extremely reasonable.

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M.-V. ROTARY CONVERTERS.

A well arranged brochure on the construction, operation and uses of rotary converters has been produced by the Metropolitan-Vickers Electrical Co., Ltd., of Trafford Park, Manchester. A feature is the large number of diagrams, one of which deals with the company's patented self-synchronising system. When the starting switch is in the "second starting position" the starting motor stator winding is connected in series with the rotary armature winding. When the rotary reaches synchronous speed the current in the armature winding gives the rotary sufficient synchronising torque to enable it to pull into step, this being indicated by the indicating lamps remaining dark, after which the starting motor stator winding is short-circuited by the main switch, so connecting the rotary slip-rings directly across the transformer. The starting switch is then opened and the rotary is ready for paralleling on the D.C. side in the ordinary way. When the starting motor switch is in the "first running position" the motor is connected directly across the transformer, and the rotary will build up its voltage as a D.C. generator and so will have the correct polarity, which it will retain after the starting switch has been thrown over to the "second running position."

The current drawn from the line with this method of starting is about 30 per cent. to 35 per cent. of full load current, and the time required for starting is approximately 30 to 60 seconds. The starting motor rotor is a plain cast steel cylinder without any windings, and is, therefore, to all intents and purposes indestructible.

Another diagram serves to augment the text on starting by means of transformer tappings, and there is a comprehensive section in the characteristics of rotaries.

Various Items.

Organ Blowing.—A reader is anxious to know if there is any book or pamphlet dealing with the wiring and fixing of electric motors for this purpose, as he would like to purchase a copy. We shall be glad if any other reader can help us to answer his query. It will be esteemed a favour.

Lectures.—A series of three lectures on "The Development of the Steam Turbine" will be delivered at the Royal Society of Arts, John Street, Adelphi, W.C.2, on Monday evenings, April 30, May 7 and 14, at 8 p.m., by Mr. Stanley S. Cook, M.I.N.A., of the Parsons Marine Steam Turbine Co. They should be of direct interest to all Central Station Engineers.

Finance.—The accounts of the Iron Trades Employers' Insurance Assocn., Ltd., to December 31 show a balance on revenue account of £211,829, from which it is proposed to return to members a sum equivalent to 40 per cent. of the annual workmen's compensation premium. This is the same rate as last year, and makes an average of 33 1-3rd per cent. for the past eight years.

Obituary.—We regret to say that news has reached the British Engineering Standards Assocn. that Dr. S. S. Wheeler, of the Crocker Wheeler Company, has just died suddenly of heart attack. Dr. Wheeler was one of the American delegates to the recent Geneva meetings of the International Electrotechnical Commission, and was a prominent member of the electrical engineering industry of America.

Electricity Commission.—The Commissioners give notice that they intend to hold a Local Inquiry at the Council Chamber, Town Hall, Liverpool, on Tuesday, May 15, at 10.30 a.m., with reference to the scheme for the constitution of the Mersey and West Lancashire Electricity District. Copies of the scheme may be obtained on application to the Secretary, Electricity Commission, Gwydyr House, Whitehall, London, S.W.1.

Sweden.—The Swedish Consulate-General in London has just published a new issue of the *Swedish Economic Review*, which gives interesting information in regard to the state of trade in Sweden, in which country it is to be hoped there will be a large field for the sale of British-made electrical apparatus.

Wiring Systems.—The 1923 edition of the *Practical Electrician's Pocket Book* has a very comprehensive chapter on this subject, dealing clearly with the leading systems now on the market. These are nearly all being advertised extensively in the electrical papers, and all contractors and wiremen should make themselves fully acquainted with their respective advantages. Therefore get a copy of the *Pocket Book* at once.

The E.T.B.I. Meeting.—On Monday, April 23, Mr. Frank Gill presided at the annual meeting of the Electrical Trades' Benevolent Institution, when the balance-sheet as submitted by the auditors was duly approved, and various other formalities were carried out. Messrs. Huddleston, Gatehouse, Robson and Blake were elected on the committee, and various votes of thanks were unanimously agreed to, including one to Mr. F. B. O. Hawes, the hon. secretary, who, as Mr. Gill truly said, was the gentleman who really did all the hard work. Naturally, hope was expressed that the funds would grow even more rapidly, and we can assure all our readers that membership of the Institution is a very sound proposition, to which they should give most careful consideration. A line to Mr. Hawes, at 18, Park Mansions, S. Lambeth Road, London, S.W.8, will bring full particulars, and we advise doing it without delay.

The Newspaper Press Fund.—Sir Ernest Benn, Bt., who is well known in the electrical industry as the moving spirit in Benn Bros., Ltd., the proprietors of our veteran contemporary, *The Electrician*, is making a stirring appeal for support for this very deserving charity. H.R.H. the Prince of Wales, K.G., is going to preside at the diamond jubilee festival dinner at the Hotel Victoria on Thursday, May 10, and as the Press of this great Empire has always given its enthusiastic assistance to worthy charitable objects, we trust that it will in return receive whole-hearted support in its application for benevolence on behalf of those connected with the newspaper Press who may unfortunately fall on evil days. Donations will be most gratefully welcomed by the Secretary, at 11, Garrick Street, London, W.C.2, and would in due course be added to His Royal Highness's list.

Entrance Schoiarships.—As a result of the Entrance Scholarship Examination, held at Faraday House Electrical Engineering College, on April 10, 11 and 12, the following awards have been made:—B. K. Watts, Aldenham School, Elstree, the "Faraday" Scholarship; J. B. Browning, St. George's School, Harpenden, the "Maxwell" Scholarship; S. Anderson, Bedford School, an exhibition of thirty guineas per annum; L. B. Law, the Grammar School, Shaftesbury, an exhibition of twenty guineas per annum; and J. Chavooshian, private study, an entrance prize of twenty guineas.

Meetings.—There will be a meeting of the Wireless Section of the I.E.E. on Wednesday, May 2, at 6 p.m. Paper: "The Design of Inductances for High-Frequency Circuits," by Prof. C. L. Fortescue.——The Junior Inst. of Engineers will meet on Friday, 27th inst., at 39, Victoria St. Lecturette: "Stock Control," by J. Fearn. Also on Friday, May 4, lecturette: "A.C. Neutral Point Earthing," by S. A. Stigant (slides); and on Friday, May 11, Durham Bursar's lecture: "The Theory of Resistance to the Flow of Gases and Fluids in Pipes," by W. F. C. Cooper, B.Sc. All at 7.30 p.m.

Trade Notes.

A booklet describing the S.I.F.A.M. Recording Instruments has been issued by **Messrs. Thompson and Co.**, of 48, Watling Street, London, E.C.4. These instruments are manufactured in Paris, and it is claimed that they have many unique features. The list is well illustrated, and Messrs. Thompson will be pleased to send a copy to any interested reader.

No. 4, Vol. II. of the *English Electric Journal*, issued quarterly by the **English Electric Co., Ltd.**, contains a magnificent series of photographs of plant constructed by the company during the year 1922, and is a fairly sure indication that, even if trade in that year was anything but normal, yet this great undertaking carried out a large amount of important work, and we can but hope that the future years will show even more satisfactory results. The price of the journal is 1s. net, and it may be obtained from the head office of the company at Queen's House, Kingsway, London, W.C.2.

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A POPULAR SCIENTIFIC WEEKLY JOURNAL
ELECTRICITY
A PRACTICAL TRADE JOURNAL

MAY 4, 1923.

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DYNAMOMETERS AND THE MEASUREMENT OF POWER.

By J. Lewis.

The extensive use of absorption dynamometers for measuring power creates the impression that due consideration is sometimes not given to the claims of transmission dynamometers, and the object of this article is not to describe anything new or original, but rather to bring before those interested possible alternatives to the commoner methods of measuring power, so that these latter shall not become stereotyped by forgetfulness to other methods, which although not of universal application, still offer decided advantages regarding the question of economy.

The commercial value of any machine which has for its function the conversion of energy, is dependent, to a very great extent, on its efficiency, that is, the ratio between the amount of energy supplied to it in one form and the amount obtained from it in the other form. The importance therefore of accurately measuring these quantities is self-evident. The b.h.p. of a machine is measured with a dynamometer and a speed counter. We have two distinct types of dynamometers —absorption and transmission—the former as a rule is in the nature of a brake, and the energy measured by this method reappears in the form of heat and is dissipated; in the latter type the energy measured does not reappear in the form of heat, but in a form that can be usefully employed.

The most elementary type of absorption dynamometer is shown in Fig. 1, and consists of two wood blocks cut to fit the pulley and clamped together, load being regulated by the thumb screws on the clamping bolts. Preparatory to using this brake we must balance it up, and this is usually done by establishing an equilibrium about a knife edge at B, by means of the balance weight W. The spring balance records the pull in pounds, exerted by the twisting moment of the machine on load, and the expression for the b.h.p. delivered is :—

$$\text{B.H.P.} = \frac{2\pi . r \ N P}{33{,}000}$$

when r is the distance in feet from the spring balance to the centre of shaft, N is the r.p.m., and P is the pull in pounds on the spring balance.

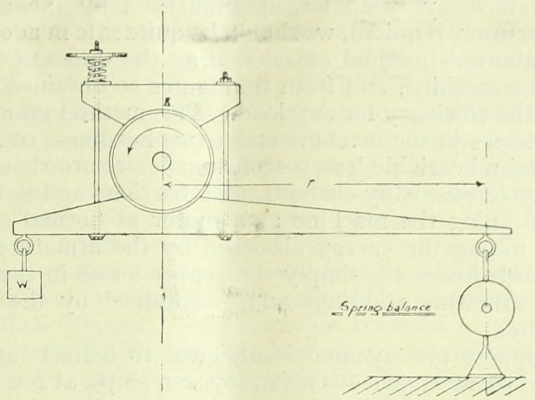


Fig. 1

This type of dynamometer has few good features about it. All the energy given out by the machine under test is transformed into heat, and this is got rid of by a copious supply of soapy water, beyond three or four h.p. We find the heat too great to be conveniently dealt with, so that its usefulness is really limited to testing small machines and perhaps demonstration purposes in the laboratory. All absorption dynamometers suffer from the defect of wasting the power of the machine under test, and this becomes serious when we consider that the usual specification demands a four hour or six hour full load test.

Transmission dynamometers, on the other hand, are fundamentally different, and the power measured by them need not necessarily be dissipated or lost. The best type of transmission dynamometer, and the best way to employ the energy measured by them, is largely governed by local circumstances and conditions, but where the local conditions embrace a supply of direct current electricity, we cannot improve on employing a dynamo for measuring the power.

There are two methods of using a dynamo as a transmission dynamometer, one of which is to couple the dynamo direct to the machine under test, then the mechanical energy given out by the prime mover is transformed into electrical energy by means of the dynamo, and the energy in this form can be usefully employed by delivering it to the supply mains. We see, therefore, that the dynamo is simply interposed between the prime mover and the supply mains, and its chief business is to convert mechanical energy into another form of energy that can be readily made use of.

In measuring power by this method, the commercial efficiency of the dynamo must be taken into account, and the b.h.p. delivered from the engine is arrived at indirectly. The output in watts from the dynamo is the product of the pressure in volts and the current in amperes, and if we divide this sum by the efficiency of the dynamo we obtain the output in watts from the engine, and dividing again by 746 we get the b.h.p., or expressing it another way :—

$$\text{B.H.P.} = \frac{\text{Volts} \times \text{amps.} \times 100.}{746 \times \text{percentage effy. of dynamo.}}$$

The type of dynamo best suited for all-round conditions will be found to be a plain shunt wound machine,

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and if designed to deliver its rated output between limits of speed by shunt control, its sphere of usefulness will be very much enlarged. The method of obtaining the efficiency being largely influenced by the degree of accuracy required, we should be quite safe in adopting Swinburne's method of calculating the different losses in the machine, and from the figures so obtained work out the efficiency for any load. This method groups all the losses in the machine under two headings, constant losses and variable losses—constant losses are those due to hysteresis, eddy currents, and friction, and is found by running the machine as a motor at normal speed, and noting the energy absorbed by the armature; the variable losses are simply the copper losses in the field and armature windings and is obtained by the $C^2 R$ formula.

Suppose our dynamo is designed to deliver at any speed between 300–900 revs., say, 250 amps. at 200 volts, and that regulation is by means of a resistance in the field circuit, by measurement we find :—

Resistance of shunt winding = 25 ohms.

Resistance of armature winding = .05 ohms.

Then from Ohm's law the shunt current will be $200 \div 25 = 8$ amps. and consequently the armature current will be at full load, $250 + 8 = 258$ amps.

We have now all the factors for calculating the variable losses at any load and may tabulate them as follows :—

	Arm. C^2R loss.	Field C^2R loss.	Total C^2R loss
Full load 250 amps.	$258^2 \times .05 = 3328$	$8^2 \times 25 = 1600$	4928
$\frac{3}{4}$ „ 187.5 „	$195.5^2 \times .05 = 1757$	$8^2 \times 25 = 1600$	3357
$\frac{1}{2}$ „ 125 „	$133^2 \times .05 = 884$	$8^2 \times 25 = 1600$	2484
$\frac{1}{4}$ „ 62.5 „	$70.5^2 \times .05 = 248$	$8^2 \times 25 = 1600$	1840

For the constant losses, run the machine as a motor at full field and normal voltage across the armature; and suppose we found the armature current to be 5 amps. at 200 volts, then the loss which is substantially constant for any load will be $5 \times 200 = 1{,}000$ watts, the total losses will be the sum of the constant and variable loss.

The commercial efficiency is :—Output of dynamo plus total loss at the given load. From the above figures we can work out the efficiency for any load. At half-load, for example, it would be :—

$$\frac{125 \times 200}{(125 \times 200) + 2{,}484 + 1{,}000.} 87 \text{ per cent.}$$

and similarly for any other load.

It should be noted that the foregoing is applicable to one speed only, in this case it would be the minimum speed, consequently for any other speed the process would require to be repeated and another efficiency curve obtained. We may not all agree that Swinburne's method of obtaining the efficiency of a dynamo is the best, but in any case it is largely used for commercial purposes, and is well within the limits of practical work.

The second method does not take into account the electrical units, nor the efficiency of the dynamo, but if a standard type of machine has been selected some slight alterations to its mechanical features are necessary. The dynamo should be supported on knife edges or ball races so that the carcass is free to rotate about its axis, and the usual practice, if ball bearings are employed, is to machine the projecting hubs of the bearing brackets to receive a ball race, arms project from the sides of the dynamo to measure, or weight, the twisting moment, and the bed plate is fitted with stoppers to limit the movement of the carcass.

Fig. 2 illustrates generally such an arrangement and is self-explanatory. The application and action of this transmission dynamometer resembles to a certain extent the simple absorption dynamometer with its brake blocks. In both cases the resistance opposing the machine under test, or the load, is due to friction, which can be varied, and the twisting moment, or torque of the prime mover, is directly measured by the pull on a spring balance.

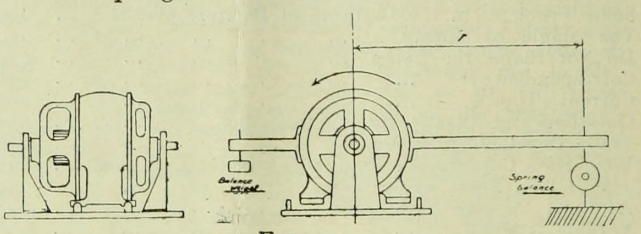


FIG. 2.

In the absorption dynamometer we have sliding contact between two solid bodies producing the friction, and the pressure applied varying the amount, whilst in the transmission dynamometer we have magnetic friction between two solid bodies not in contact, that is, the armature and field magnets, and this magnetic friction is varied by the amount of current drawn from the armature. The carcass, or the field magnet system of the dynamo, occupies the same position in this dynamometer as the brake blocks in the absorption dynamometer, consequently the twisting moment of the prime mover is weighed or measured at the carcass exactly as we do at the brake blocks, and it follows therefore that the same expression for the b.h.p. holds good, namely :—

$$\text{B. H. P.} = \frac{2 \pi r \text{N P}}{33{,}000.}$$

The electrical energy given out by the dynamo is, of course, delivered to the supply mains, and in this way all the power other than the small amount lost in conversion is very usefully employed. The small amount of friction at the ball races is not covered by the above expression, but if care is exercised in assembling the apparatus, and the carcass correctly balanced, the friction is negligible; it can, however, be separately measured and allowed for in the final result. As an alternative to using ball races, should there be a difficulty in applying them, it is possible to substitute a system of knife edges, and a satisfactory arrangement can be designed which in no way alters the mechanical features of the dynamo.

Nine Bob!—It does not sound very big, even in face of the penny saved on each pint, but one can do lots of things with it. One excellent idea is to send it to Dept. 140 E.P. of H. Fitzpatrick, at Burnley, as the first payment for one of his world-famous "Captain" cycles, as advertised in this paper. Now is the time to take to the open road, not with Black Bess and a black mask, but astride one of these trusty machines. The joy of riding in the fresh air during the long evenings will make one feel thoroughly invigorated and ready for the next day's work. Difficulties will be smoothed over, and the results will all make for efficiency. The medicine is good. Give it a trial, or, at any rate, write and ask for the illustrated catalogue giving full details.

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SOME PROBLEMS IN THE LIGHTING OF PRINTING WORKS.

In his paper on the above subject, before the Illuminating Engineering Society on April 24, Mr. L. Gaster recalled that this was not the first time that they had dealt with the lighting of printing works. Two papers were read by Mr. Eck and Mr. Goodenough in 1912, but in the subsequent years there had been important developments in lighting, and it was opportune to survey the subject anew.

Mr. Gaster quoted Mr. Goodenough's remark, "I doubt if there exists any industry in which good lighting has more effect on the successful running of the concern than is the case in the printing trade." In a modern newspaper works speed must be combined with accuracy; the product of both journalists and printers is prepared exclusively to *appeal to the eye*. Therefore, the work of preparation must be done under good lighting conditions.

In discussions before the Illuminating Engineering Society it has been shown repeatedly that the cost of proper lighting forms but a small part of the cost of production. We may estimate that in printing the cost of artificial lighting amounts to about 1s. per man, and that the average wage may be £4 to £5 a week. Thus the cost of lighting forms only 1 per cent. of the wages bill, and any expenditure leading to improved illumination will be amply repaid.

Mr. Gaster then proceeded to discuss various problems, notably the lighting of rooms in which compositors are at work. It was formerly usual to devote a local shaded light to each frame, but in some modern installations general lighting throughout the room giving 10-12 foot-candles is met with. Some photographs taken by Mr. Dow were exhibited illustrating conditions in such cases. There must be ample illumination on the frames (at least 5 ft-candles), and the light should be well diffused so that drawers are not left in shadow. The proper lighting of the huge rotary presses in newspaper buildings of to-day is a difficult problem. It is hardly possible by general lighting alone to illuminate the interior of such machinery. Well-shaded local lights may be used, but the best results would probably be obtained if designers would provide for permanent lights as an integral portion of the machine. The values of illumination usual for machine rooms, linotype machinery, etc., were tabulated by Mr. Gaster, who showed that the requirements of the Home Office Departmental Committee could easily be complied with by modern methods.

Attention was also devoted to the needs of the editorial staff. Those who are engaged in studying manuscripts and proofs need exceptionally good illumination and local well-shaded lights, affording a minimum of 5 foot-candles on the paper, should be available, supplemented by general illumination. Mr. Gaster also put in a word on behalf of the reporter who attends public meetings. The Press table is not always as well lighted as it should be, and shorthand writing in pencil, in particular, requires a good light. Mr. Gaster concluded by pointing out that the complex problems involved in the lighting of printing works require the co-operation of lighting experts and those engaged in the processes to be illuminated. The suggestions made in the paper were tentative and based on good modern practice, but he proposed that the subject should be dealt with in detail by the appointment of a small joint committee.

The value of such co-operation was illustrated in the discussion, which was attended by a number of representatives of the printing industry. The Right Hon. C. W. Bowerman, a past president of the Joint Industrial Council of the Printing and Allied Trades of the United Kingdom, expressed his warm approval of the paper, and contrasted the attention now being devoted to the subject with the inefficient methods of the past. The Council would welcome the help of the Society in dealing with this problem. Mr. Holmes and Mr. Goodwin, secretaries of the Council, and Mr. G. A. Isaacs, secretary of the National Society of Operative Printers and Assistants, also referred to the paper in sympathetic terms. The discussion revealed a general appreciation of the need for joint efforts on the part of the industry and the Illuminating Engineering Society in order to solve the problems presented.

THE MAGIC OF SPRING.

Never sleeping throughout the year, E.D.A. has shown even increased activity this spring in the publication of telling literature. In a batch which recently reached us are the following, all delivering their message in the cause of higher civilisation in a most appealing manner: The Artificial Lighting of Schools; More Light (notes on improved home lighting conditions); The Power for Progress and Production (extracts from a lecture before the Society of Arts, by J. F. Crowley, D.Sc., B.A., M.I.E.E., on the Advantages of Electric Driving); Make Your Business Better Known! (on the Sign Informative and the Sign Appealing); The Magic of Spring (a small, very fine illustrated folder of few words showing how electricity overcomes dirt and toil); The Home of 1923 pamphlet, already referred to in these columns; and a large folder giving particulars of a joint publicity campaign carried out by E.D.A. on behalf of the E.S. undertakings, contractors and other interests in the Aire and Calder district.

There is also a wall card explaining how aluminium saucepans should be cleaned, it having been found that soda does not attack aluminium if to one ounce is added not less than 1-10 ounce of waterglass to the gallon. "Carbosil," "Pearl Dust" or "Aquamol" are recommended cleansers for the purpose.

Readers may also be reminded again of the slogan competition already referred to.

Considering that the above form only one part of E.D.A.'s many activities, it is surely well worthy of every support. The address is: British Electrical Development Association, Inc., 15, Savoy Street, W.C.2.

Will.—Sir John Gavey, the telegraph and telephone pioneer, and consulting engineer to the G.P.O., left £9,318.

Room to Breathe.—The Machinery Hall at next year's British Empire Exhibition will cover an area about six and a half times bigger than Trafalgar Square. Think of it, and what a magnificent object lesson the exhibits therein will present to the hundreds of thousands of visitors who are expected from all parts of the world. It ought to bring orders enough to keep the British engineering industry going full speed for years, and we must all do our best to see that such an event does happen. It is up to us to advertise it for all we are worth.

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DO NOT BLAME THE LAMP.

Contractors and lamp retailers are occasionally blamed because gasfilled lamps have given out after a very short life run, and a contributor to our esteemed contemporary, *The Kinematograph Weekly*, draws attention to this and explains that in each case in which he had been consulted he found that the new gasfilled lamps had replaced ordinary vacuum type lamps shaded by a cut glass or tinted glass shade. The new lamps gave out quickly because there was not sufficient air space between the bulb and the size of shade which had hitherto been used.

The reason for this trouble is that, owing to the high temperature at which the filament of a gasfilled lamp operates and the conductivity of the gas itself, the glass bulb of the lamp is maintained at a much higher temperature than is the case of a vacuum lamp. If this temperature be again raised owing to lack of cooling facilities, the glass tends to give off gas which is detrimental to the filament, thereby causing a shortening of life.

The moral is—use a larger shade when such replacements are made, and take care that clients are advised on this point when they wish to make changes of this nature. A satisfied customer is always a good asset.

Correspondence.

OHM'S LAW.

To the Editor of ELECTRICITY.

SIR,—In his lucid explanation of the thermionic valve (p. 207), "Silver Medallist" makes a statement which I think he cannot substantiate. He says: "The current resulting from the voltage applied between *P* and *F* does not comply with Ohm's law." Will "Silver Medallist" tell us, then, with what law it does comply?

If we have a varying voltage and a varying resistance, Ohm's law is just as true as if both factors were constant; *but* we must be precise and say that the current in a circuit at any instant is directly proportional to the voltage applied at that instant, and indirectly proportional to the resistance at that instant.

The student should never be taught to doubt a fundamental law.

Yours faithfully,
FRANK BROADBENT.

Coulsdon.
April 24, 1923.

Note by the Writer of the Serial.—Ohm's law states that at any instant the ratio of the steady applied voltage to the resulting steady current in a circuit is a constant quantity, which is termed the resistance of the circuit, or

$$\frac{V}{I} = R \text{ (a constant).}$$

In the case of the thermionic valve, however, the ratio of the voltage applied between the plate and filament to the resulting current is not a constant quantity, but varies according to the voltage applied, or

$$\frac{V}{I} = f(v).$$

i.e., a function of the voltage. We may, of course, say that $f(v)$ is the instantaneous *apparent* resistance and, therefore, at any instant

$\frac{V}{I}$ = apparent resistance of plate to filament.

The sentence was not worded as happily as it might have been.

AIR DEFENCE BRIGADES.

To the Editor of ELECTRICITY.

SIR,—As doubtless you are aware, the formation of two Air Defence Brigades, Territorial Army, have been authorised in London, each brigade comprising artillery, engineers and signals, with co-operating aircraft.

An effort is being made to bring the units up to strength with the right type of men as quickly as possible, in order that the greatest benefit may be obtained from this year's camp in August, and also to improve the facilities for our defence against aerial attack.

The enclosed is a copy of a letter which is being sent to a number of firms in the vicinity of London. As, however, it is not possible to circularise every employer and employee, would it be asking too much of you to publish it in your journal, so that the existence of these brigades, and of this R.E. battalion in particular, may be made known as widely as possible?

I am, sir, yours faithfully,
G. O. ALABASTER, Major, Adjt.
For Lieut.-Col. R.E. (T.A.)
Com. 10th (London) A.A. Batn. R.E. (T.A.).

Duke of York's Headquarters,
Chelsea, S.W.3, April 30, 1923.

[*COPY.*]
Duke of York's Headquarters,
Chelsea, S.W.3,
April 28, 1923.

GENTLEMEN,—In view of the widespread publicity which has of late been given to the state of the air defences of our country, and the imperative need for definite action in regard thereto, I take this opportunity of addressing your firm in the interests of recruiting.

A vidid recollection of the havoc caused by air raids in the late war should prove a sufficiently strong incentive to come forward in the case of many who must realise that air defence and home defence are now practically synonymous terms.

It is possible that an appeal in this direction may have been made to you already. I should nevertheless be glad at any time to explain to your staff personally the general rôle of the new Territorial Air Defence Formation for the protection of London, with the hope of raising an entire unit from the personnel of your firm.

It is hoped that such a unit, if raised, would be closely identified with the name of the firm to which it owed its origin, so retaining essentially its own *esprit de corps*, and combining in its formation a patriotic and industrial enterprise of the first importance.

Yours faithfully,
(Signed) D. HOWARD GILL, Colonel,
Com. 2nd Air Defence Brigade (T.A.).

[We have much pleasure in inserting the above correspondence, as we are sure it will appeal to many of our readers.—Ed., ELECTRICITY.]

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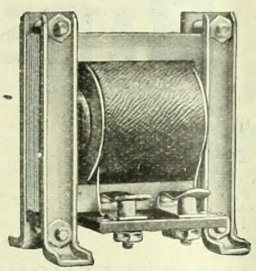
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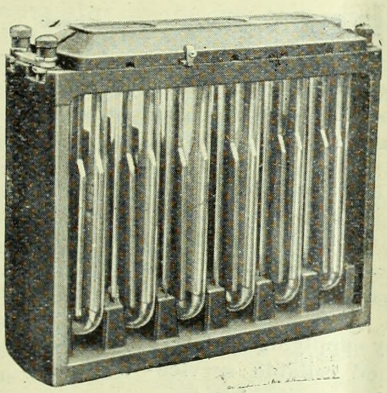


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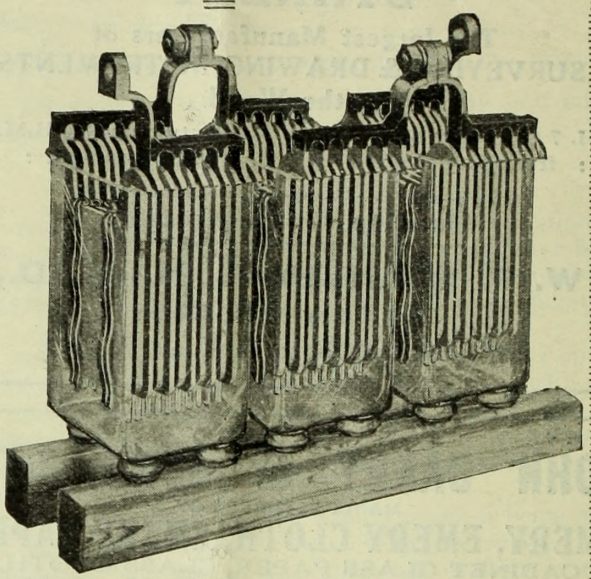
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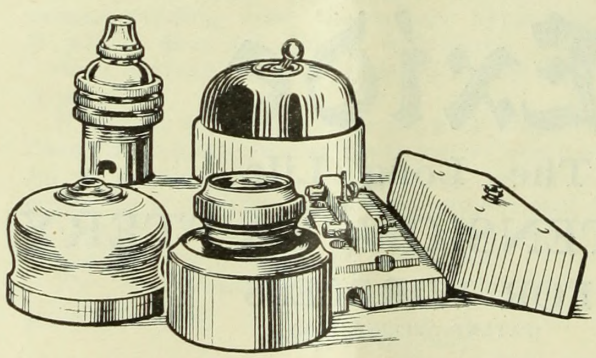
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TO OUR READERS.

ELECTRICITY is published every Friday, and, if ordered, is on sale at the principal Railway Station Bookstalls and Newsagents on that day. It has a very large sale throughout the United Kingdom, as well as in the British Colonies and Abroad.

New advertisements for the displayed columns and alterations to existing ones must reach the publishing office not later than first post Tuesday morning, in order to be in time for the issue of the following Friday. This is important. Rate quoted on application. Subscription: 13s. a year, 6s. 6d. half year, 3s. 3d. a quarter in advance, postage prepaid in the United Kingdom and abroad.

Questions to which an answer is required must be accompanied by a 1½d. stamp for reply. When considered of sufficient interest, the answer will probably appear in the paper.

All remittances payable to the Publishers, S. RENTELL AND CO., LTD., 36-39, Maiden Lane, London, W.C.2. Telephone No. 2460 Gerrard.

Current Topics.

Cheap and "Nasty."

Having occasion to inspect a conduit wiring job in progress the other day, I took advantage of the occasion to examine some of the modern conduit tees, bends, and other fittings which were lying on a near-by bench in readiness for use by the wiremen engaged on the work, and was rather surprised to note the degeneration which has taken place in the quality and workmanship of this protective system of tubing since the days many years ago when I actually handled it in the course of business. The conduit under criticism was of the slip-joint variety, and appeared to be made of the cheapest and thinnest possible metal, with no great pretensions even to being truly cylindrical. Nasty burrs and dents were much in evidence, and the clamping collars and screws were of the flimsiest description; in fact, the whole of the material I examined suggested the description with which this paragraph opened, and I wondered whether the conduit trade had really degenerated or whether I had struck a particularly bad specimen of conduit sundries.

Admittedly the function of conduit is mainly as a species of cheap metallic armour or protection for the enclosed conductors against the dampness and other deleterious contents of plaster, brickwork, etc., and allowing also for the fact that wiring costs have to be cut down to the last halfpenny in order to tempt new consumers, the fact remains that it is possible to turn out a presentable job and in any event to eliminate those factors which in defective conduit contribute to faults and breakdowns. If the stuff I saw is any criterion of what is being erected in some latter-day houses I predict early trouble for the consumer, especially if the conductors subsequently drawn into it are of the same order in regard to quality of insulation. "It doesn't matter what the job looks like now, it will be out of sight when the wiring is finished," seems to be the order of the day with some of the less principled contractors, and this experience adds force to the Hull criticisms to which I referred a week or two back.

The wiring trade would do well to keep before it the example of the gas-fitting industry. Gas-lighting is still a competitor to be reckoned with, and we have so often pointed the finger of scorn at the decadence of gas fittings, burners and components generally, that we cannot afford to endanger our own prosperity by following suit. Similar criticisms could be applied to a good many of the lower-priced electric lighting components now being offered at knock-down prices; some of them are very shoddy, and it is simply asking for trouble to install them in the first instance. I imagine that there has been a good deal of Continental dumping going on since the war which would account for some of the trash which is now so freely sold and used by the class of wireman of whom complaint is so rife at the present time.

Railway Grouping.

An esteemed correspondent and technical expert in railway matters takes me to task over my comments in a recent issue on the prospects of greater electrical advancement as an outcome of the grouping of our principal railways. My critic takes those remarks as a personal slight on the very valuable and admittedly progressive development work which has been accomplished by the various technical staffs of the railways during the past fifteen to twenty years, a suggestion which is wide of the mark. As an onlooker I am conversant with, and find much to commend in, the thorough and painstaking way in which the individual engineering and technical staffs of the various railways have done their best to progress in face of the difficulties they have had to contend with in the past.

My remarks were aimed at the system, or the organisation which did not give full rein to these ambitions, and which it is to be hoped the new arrangement will encourage. Mr. Tweedie will, I think, be the first to admit the difficulties of making progress with new ideas, and securing their adoption as general practice on British railways in the face of out-of-date Board of Trade regulations, managerial red tape and the tradition inseparable from any such extensive organisation as the one with which he is associated. It is a fact that we possess railway and signal engineers quite equal to, if not better than, those of any other country in the world, but unquestionably their past activities have been hampered by the conditions referred to, and the obsolete methods still in vogue on several of our railways are standing proof of the truth of this allegation.

Telephone Etiquette.

The *Daily Mail* has discovered a new species of complaint against the much-maligned telephone service. In this case the blame does not lie with the long-suffering operator at the public exchange, but rather with the manipulator of the calls incoming to and outgoing from what are known as private branch exchanges. A practice has arisen and become more or less firmly established in large business establishments whereby a principal, wishing to speak to a contemporary in another business, also possessing many telephones, deputes the duty of calling to a subordinate, whom he instructs not to advise him that his connection is really through until his correspondent is at the other 'phone and actually waiting to hear what he has to say. Although doubtless economising the caller's time, such a system is scarcely fair, or even courteous, to the called party, in that it involves wasting the perhaps equally valuable minutes of the other fellow.

Another aggravating practice is that which involves repeating one's requirements twice or three times over

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because the first or second person who answers your call is not competent to deal with the business in hand and hasn't the good sense to ask your business in the first place. In telephoning via a private branch exchange it is a sound rule, having first ascertained that you are on to the right number, at once to ask for the department or individual to whom you wish to speak. Neglect of this obvious procedure leads to endless irritation and loss of time on the part of everybody concerned with that particular call. Curiously enough, the general advent of automatic telephony will remove a good deal of this trouble, inasmuch as "dialling" one's desired number is such a simple and rapid operation that even busy principals will be able to spare the few seconds necessary, and will find it less necessary to rely on their secretaries or subordinates to do their telephoning for them.

Pity the Poor Battery.

It is a tribute to the development of the traction or heavy-discharge type of storage battery and the workmanship put into it that these essential components of the average electric vehicle stand up to their work so well and for such long periods without expert attention. In an interesting article on electric vehicle breakdowns, my contemporary the *Electric Vehicle* expresses the view, which is doubtless a correct one, that the majority of breakdowns would have been impossible had the vehicle as a whole been given one-quarter of the attention devoted, as a matter of course, to the petrol-driven variety. There is an unfortunate tendency on the part of some men in charge of these vehicles to regard the battery literally as a "tank for electricity," and treat it accordingly, yet it is advisable to ensure by systematic inspection that the "tank" is not leaking, or otherwise defective. Some sound and practical advice is given in the article, which should be read by all in charge of battery-propelled vehicles.

The Lighting of Printing Works.

Those concerned with newspaper production, whether as printers or as journalists, should be grateful to the Illuminating Engineering Society for its efforts to improve the standard of lighting. In his paper before the Society on April 24 Mr. Gaster showed how complex and varied are the problems met with in a printing works, and how important it is to secure the co-operation of the user of light as well as the expert in deciding the best method of illumination. The meeting was attended by a considerable number of those concerned with printing, including representatives of the Joint Industrial Council of the Printing and Allied Trades. Their sympathetic reception of the paper shows how much can be done by approaching users of light and inviting their views, and there is no doubt that this discussion will have a material effect on methods of lighting in printing works throughout the country.

Journalists who spend their days preparing and examining manuscripts and printed matter have every reason to appreciate the benefits of good lighting, and Mr. Gaster did a good service in drawing attention to their needs. It is to be feared that there are still many offices in which the journalistic work is done under bad conditions in this respect. But negligence of illumination is usually the result of oversight, and here again the dissemination of the conclusions expressed at this meeting should have a good effect.

The E.C.A. Dinner and—

I congratulate Mr. Marryat, the president, Mr. Tate, the secretary, and the members of the Electrical Contractors' Association generally on the success of the annual dinner on the 24th ult. It was remarkably well organised, and the 140 (more or less) members and guests who were present had the pleasure of listening to some very interesting speeches. To start with, Mr. Wordingham, who proposed "The Allied Associations and Their Honorary Officials," struck a true note when he said that, from its first inception, the Association had been fortunate in the type of men who had been presidents, and they had at different times given the I.E.E. much valuable assistance in technical matters. Further, the policy of the Association appeared to him to be eminently consistent in its aim of improving the quality of the work carried out, and not simply one of forcing up prices.

In that sense, he said, they appeared to be emulating the C.M.A., which had been working steadily and most commendably to improve the quality of electric cables, with the result that enlightened purchasers were fully prepared to pay C.M.A. firms 10 per cent. more for their cables because they represented more than that value in the way of insurance against faulty work. He gave his full and cordial approval to the suggested registration of contractors, although he thought that at first it should be entirely voluntary, even if it were made compulsory in the ultimate future.

—the I.E.E. Wiring Rules.

Then Mr. Wordingham referred at some length to the Institution Wiring Rules. He is chairman of the committee which is supposed to be undertaking their revision, and he told us with a smile of his difficulties in that position in face of the irreconcilable views held by some of the members. Municipal engineers, for example, were pressing for compulsory rules with very clearly defined limits. Company engineers wanted broad-reading rules, which would allow plenty of latitude, and some engineers even suggested no rules at all. Another man would argue on the basis of a very close specification, and his opponent maintained that it should be as open and free as possible. The position almost forced him to ask, "Do we want these Wiring Rules?" In other words, were we not trying to teach the wiring contractor his business, and was it the wisest plan to issue any rules at all? Alternatively, why should it not be left to an expert association, such as the E.C.A., to produce good work in compliance with any simple outline requirements?

Mr. Marryat responded to the toast which accompanied Mr. Wordingham's speech, and he referred promptly to the problem which would be raised if there were no I.E.E. Rules. It would be chaos, because every local engineer would draw up his own set of rules, and so would every fire office. I am certain, therefore, that all contractors will look forward with eager anticipation to the production of a revised set

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of rules worked out on a broad common-sense basis which will make full allowance for safety, and yet be no handicap to enterprise.

Mr. Marryat then spoke up boldly for the provincial electrical contractor and said how useful an ally he could prove to the local station engineer. He quoted Leicester as an example, and pleaded that engineers should appreciate the wisdom of concession to and co-operation with the contractors, who could make the best and most effective use of any available facilities and thereby increase the customers by thousands. As a matter of fact the electrical industry needed better organisation and less of the present indecent scramble to be first. Our health, wealth and prosperity must depend on a successful body of retailers, and we ought really to come to an amicable understanding between manufacturers, wholesalers, retailers and contractors. The E.C.A. had that day issued an important declaration of their trading policy, and he hoped that other bodies would follow suit.

Mr. W. R. Rawlings proposed "The Guests" in a very humorous speech, and replies in a similar vein were made by Mr. W. W. Lackie, Mr. Frank Gill and Mr. W. B. Woodhouse. Mr. Gill also told us that in France and Italy he saw an immense amount of surface wiring, and it was quite successful. Houses and factories were not constantly being burnt down, and he wondered whether English engineers were not too meticulous and fussy. To which I expect many contractors would give their most unqualified assent.

Then Mr. Marryat proposed "The Electrical Trades Benevolent Institution," and passed round an autograph letter from the father of our great industry, viz., Michael Faraday. It was dated from the Royal Institution, Albemarle Street, in 1839, and was perused with keen interest by many of those present, who also supported Mr. Marryat's appeal by contributing to the bag which was passed round with the letter. Meantime, Mr. J. Y. Fletcher replied for the E.T.B.I. and told us that the invested funds were now over £20,000 but we wanted more, and pleaded with the electrical contractors to join up and get their men to do so, because the modest 10s. per annum which it cost brought some really marvellous privileges in its train. Finally Mr. H. J. Cash proposed "The President" in very felicitous terms, after which Mr. Marryat returned thanks and told us that the collection for the E.T.B.I. had realised £41 2s. 6d., and Mr. Orringe's bid of 10 guineas for the Faraday letter was added thereto, making a total of £51 12s. 6d. to be added to the funds, for which Mr. Fletcher expressed his heartfelt thanks. I should also add that there was an excellent musical programme interspersed between the speeches, and altogether it was a most successful evening.

ELEKTRON.

Prize Winners.—The prize winners, and the first prize-man's winning scheme, in *The Electrician* All-Electric House Competition, were published in last week's issue of that journal. The first prize winner is Mr. P. E. Peronne (of London), the second Mr. W. M. Craufurd (also of London), and the third Mr. E. Whytock (of Glasgow). A second competition for the design of an electrically-heated hot water installation for a middle-class house is now in progress, the first prize being twenty-five guineas.

Questions and Answers by Practical Men.

RULES.

QUESTIONS: *We invite our readers to send us questions, preferably on technical problems that have arisen in actual practice. Questions which we consider of sufficient interest to our readers will either be replied to under "Answers to Correspondents" or replies will be invited from our readers. One shilling will be paid for the question which we select for competitive replies in this column.*

ANSWERS: *A fee of 10s. will be paid for the answer which we consider shows the greatest merit, and 5s. for the one we select as second best. In judging the replies, importance will be attached to clearness and conciseness, as well as accuracy. The Editor reserves the right to make no award, or to accept only one reply, if, in his opinion, the answers received do not possess sufficient merit. Competitors desiring the return of their manuscripts, if unaccepted, should enclose stamped addressed envelope.*

Write on one side of the paper only, and if diagrams are sent, draw them on a separate sheet of paper attached to the manuscript. Competitors may adopt a "nom de plume," but, both in the case of questions and answers, the competitor's real name and address must be sent with the manuscript as a guarantee of good faith. No correspondence will be entered into with regard to successful replies. The Editor's decision is final.

Commencing with Question No. 101, a Diploma of Merit will be awarded to the six competitors who win the first or second prize the most times during the next twelve months.

The words "Questions and Answers" or "Q" and "A" should be placed at the top left-hand corner of all letters intended for this column.

QUESTION NO. 159.

I wish to decrease the speed of a direct current motor under my charge. I desire to do this without the insertion of resistances, which I understand are very wasteful. How can I most efficiently do this? The motor is 40 h.p., 220 volts, compound wound.—"INSPECTOR."

QUESTION NO. 160.

When looking through an old book on cable laying I came across the expression "cable should be taken from the drum and laid in a figure of eight upon the ground before being drawn into the duct." Can any reader tell me why this should be, because the book does not tell me why?—"JOINTER."

(Replies to Questions 159 and 160 must be received not later than May 26, 1923.)

Answers to Questions.

QUESTION NO. 154.

I have a new accumulator enclosed in a celluloid case. Its capacity is 50 ampere hours. I notice that sulphating has commenced to take place, not on the plates, but on the bars which hold the plates together. Is this injurious? If so, how can I prevent it?—PAX."

REPLIES TO QUESTION NO. 154.

Note.—The replies to this question were of such an excellent nature that it has been decided to award two second prizes of 5s. to the second prize winners. The first prize (10s.) has been awarded to "F. D. S." for the reply below. Although his technical details in the reply are much more copious than any other competitor, and are excellent from a maintenance point of view, we cannot agree with his statement that "the cell should never be discharged below 2 volts." It is best to follow the makers' instructions in this matter. As a general rule, the manufacturers specify that their cells shall not be discharged below 1.8 volts.—Editor, ELECTRICITY.

QUESTION NO. 154.—FIRST PRIZE ANSWER (10S.)

The cause of the sulphating of a lead accumulator is either the wrong strength of the electrolyte or the continued non-use of the cell. In the former case the fault may have been due to using acid of the wrong strength in the first filling, or else the wrong addition of acid or water during the topping in use. If the density of the acid is too high, sulphating is greatly

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accelerated. In the other case of non-use the effect is the same, owing to the continued action of the sulphuric acid. In this case it can be avoided by giving the cell a gassing charge at least once in two months.

In the present case, as the action is only on the bars, it may be taken that the effect is due to a change of level in the electrolyte, thus leaving acid to dry on the very partially formed surface of the connecting bars. The drying of this acid is a sure source of sulphating. The bars had, of course, become slightly formed during the time that they were covered.

The best method for the removal of sulphate is the electrolysis of sulphate of soda.

The solution is made up using one part of pure sodium sulphate in five parts of distilled water, and this solution is poured into the cell after removal of the acid and rinsing. The current is then applied to the cell at the eight-hour rate, in the charging direction, for a period of time depending on the extent of the sulphating. In bad cases the operation may take as long as fifty hours.

The chemical action is the formation of sodium hydrate or caustic soda at the lead plate, and sulphuric acid at the lead oxide plate. The sulphate is thus reduced at the lead plate by the caustic soda and oxidised at the lead plate by the sulphuric acid.

When this process is complete, the cell must be well rinsed out several times and at once charged in the ordinary manner.

The sulphate may be reduced or oxidised by continued use—that is, by the charge and discharge in the ordinary way—if care is taken that the acid level never falls, and that the cell is never discharged below 2 volts.

Another method that is in great practical use is to open the top and scrape away the sulphate, but this is not to be recommended, as the sulphate is very brittle, and a certain amount of damage to the cell is unavoidable. The celluloid case is, in this case, resealed, using a solution of celluloid in amyl acetate, adding the latter until the required thickness is obtained.

The presence of sulphate greatly reduces the capacity of the cell, but since the bars have practically no capacity, the presence of sulphate can have no effect; and since this is not a disease that spreads, the cell is no less efficient. It is, however, a mark of previous bad treatment, and it is therefore desirable to remove it, at least in the opinion of most engineers. Sulphating can never occur if the acid is kept at the correct density (1.200 when charged), and sufficient if gassing charges are given.—" F. D. S."

One second prize (of 5s.) has been awarded to " Ampere-Hour " for the following reply:—

The collection of sulphate upon the plate-connecting strap of an accumulator is not injurious, providing none of it finds its way to the plates. The effect of sulphate forming on the parts of an accumulator is that it covers the surface of the article with a powder-like substance, and finishes at that. Now, as the plates of a battery are covered with active material, the formation of sulphate upon them is bound to reduce their active surface in contact to or with the acid solution.

The plate-connecting strap simply connects the negative or positive set of plates together, one strap for each, and, as there is no active material upon these straps, sulphate does not do them any harm. However, if the owner should prefer to remove it, he may do so by taking the lid off the case (which is not as difficult as it sounds), and the sulphate will come off quite easily when rubbed with a toothbrush dipped in a weak solution of sulphuric acid. If the idea of lifting and re-cementing the lid does not appeal to the multitude, a small brush with a wire handle, as used for cleaning test tubes, etc., may be inserted in the cell by means of the vent hole, and the offending sulphate removed in a short time by rubbing with the brush. It should always be remembered by all accumulator users that leaving the battery discharged for any period is the root of all trouble, sulphating being the most prominent.—" AMPERE-HOUR."

A second prize (of 5s.) has been awarded to " M. M." for the following reply:—

It is not at all uncommon for new accumulators to have their parts covered with a white powdery deposit; if this is the only evidence against satisfactory performance there does not appear to be much cause for alarm.

It would be a good thing to rinse the cell out with electrolyte before finally filling up ready for charging.

Occasionally new plates throw off a considerable quantity of flakes; in such a case, a swill out and a change of electrolyte after a few discharges will no doubt put the cell in a healthy condition.

If the cell has been used, or even filled with electrolyte and then emptied, this may account for the presence of white particles indicating what goes under the term " sulphating." The cure for this is long charges at low values of current.

Also, if the cell has been in use some little time, patient charging at a low rate will probably make things satisfactory.

The best policy for " Pax " is to rinse out and charge slowly; it will be soon enough to open the cell and clean the plates and connections when there is evidence of serious trouble.

Should it be found necessary to thoroughly overhaul the cell, go round the top with a thin-bladed knife, " breaking " the joint. Remove top, when plates can be easily taken out. Swill, brush, and, if required, straighten the plates. Paste for cementing in the top is made by dissolving celluloid in amyl acetone.—" M. M."

TRADE DEVELOPMENT IN CANADA.

An interesting and straightforward proposition is being developed in connection with the determined effort of British manufacturers to extend their overseas trade, especially in Canada, by the Ancona Books, Ltd., of Sentinel House, Southampton Row, W.C.1.

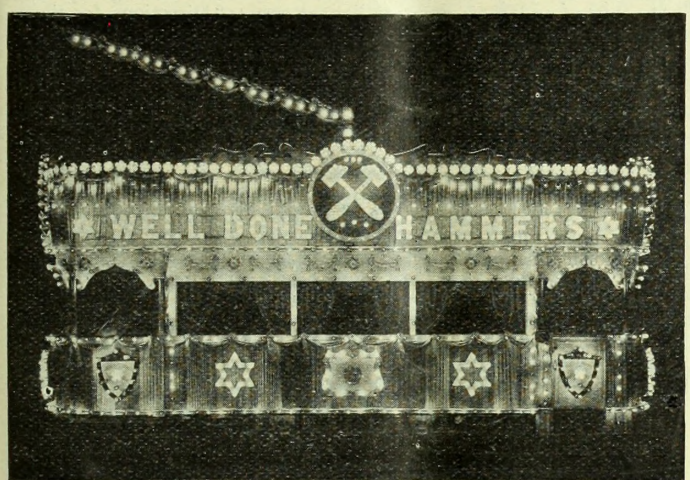
The proposition comprises the advertising, marketing and merchandising of their clients' products, *i.e.*, it encourages the retailer to stock their advertisers' goods by assisting him to sell them to the consumer. The features of the scheme, which certainly merits investigation, include a 30,000 guaranteed circulation of the advertising media, which is distributed to retailers,

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importers, Chambers of Commerce, etc., as well as to a selected public—also personal visits to Canadian agents, publicity by film lectures and sales adverts. in the form of circularising lists and showcards. Payment is only demanded, we understand, on the advertiser receiving a chartered accountant's certificate that the conditions above-mentioned have been fulfilled.

WEST HAM CORPORATION TRAMWAYS AND THE CUP FINAL.

The record of the West Ham team during the present football season has accounted for tremendous local excitement, and the Council and Mr. M .L. Slattery, the General Manager of the Corporation Tramways, decided that the occasion should be marked by some electrical celebration, whether West Ham actually won the Cup or earned for themselves the runner-up Medals. The West Ham public will doubtless appreciate the interest taken in this local event by their tramway manager and the Tramways Department, more especially as an illuminated tramcar of unique



design has been produced for this purpose. Naturally, the colours of the West Ham team figured conspicuously in the colour scheme adopted for the illuminated tramcar, and although we reproduce herewith merely a black and white illustration, the following description will give a more adequate idea of the skilful blending of the colour scheme employed.

Approximately 2,000 Siemens' Traction type electric lamps were used, and these were coloured red, white, and blue in the quantities required to attain the desired effect. These lamps are of the same type as the standard Siemens Traction lamps which are in use on the West Ham tramways system. The trolley arm was picked out in red, white and blue lamps spaced six inches apart. The top deck of the car was draped in blue, the rails being lined with red, white and blue lamps. Illuminated festoons were hung the whole length of the car on either side, with a central design representing crossed hammers. This was picked out with white lamps on a red background, and surrounded by a circle of white lamps. Underneath was picked out the legend "Well done, Hammers," in white lamps with blue draping for a background, and this occupied the whole length of the car on either side. The windows were tastefully draped and picked out with red, white, and blue lamps, also all the uprights and platform stanchions. Underneath the windows there were two shields, two stars, and one central medallion containing the armorial bearings of the Corporation. These were picked out with white lamps on a red background. On the front and back of the car on a level with the upper deck was an oval medallion or brooch containing red, white and blue lamps, while at the platform end there was a large star similarly picked out in coloured lights.

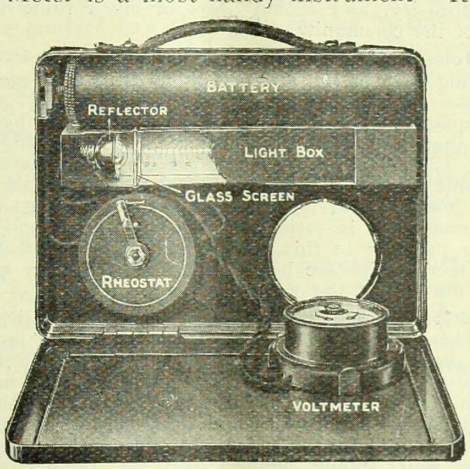
The lamps were wired five in series, Siemens 105-volt 30-watt Traction type lamps being used on a 500-525 volt supply. The wiring was run to four 60-amp. Siemens "ZED" fuse boxes and circuit breakers, the maximum load in any one circuit not exceeding 35 amps.

It was arranged that the team should travel from Wembley by private car, and that they should be met at the boundary of West Ham by the Mayor and Corporation. The illuminated tramcar carrying the local Police Band preceded the private conveyance containing the team, the directors of the Football Club, and friends, over the greater portion of the Corporation's tramway system. It was arranged that the team should arrive at about 8.30 p.m., and that the journey should finish somewhere about midnight.

The scene, therefore, was laid for a tremendous local reception of the local team, and there was naturally some disappointment that they were not successful in winning the trophy, but this in no way minimised the interest exhibited in the illuminated car produced by the Tramways Department. The public generally formed the opinion that the Corporation had paid a well-merited compliment to the successful performance of the team in not only securing the runner-up Medals, but also for the very consistent play in the English League games.

THE B.T.-H. FOOT-CANDLE METER.

In order to measure easily and simply the amount of light at any point, or on any surface, the B.T.-H. Foot-Candle Meter is a most handy instrument. It is con-



tained in oxydised sheet steel casing, with a leather grip at the top; the whole going into a leather case, with sling strap for carrying. The total weight of the complete instrument, without the leather case, is 3 lb., and the outside measurements $7\frac{7}{8}$ in. by 6 in. by $1\frac{1}{2}$ in. We illustrate the instrument with the back of the case

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opened. A section of the light box is cut away to show the lamp and a part of the reverse side of the screen. As will be appreciated, the instrument is readily carried from place to place as required. It is easy to read and contains all the requirements necessary to secure accurate readings. Full particulars can be obtained from the British Thomson-Houston Co., Ltd., 77, Upper Thames Street, E.C.4.

A LONG SERVICE ASSOCIATION.

A new association has been formed at the Metropolitan-Vickers Electrical Company's works at Trafford Park, the members of which can all show 20 years' service or more. It speaks well for the conditions of service with the company when it is recorded that there are already 302 members of this association, the majority of whom, including ten women, are workpeople.

On Monday, April 30, the association held its first dinner and social evening at the works. The two toasts of the evening were "The Metropolitan-Vickers Electrical Company, Ltd.," and "The Metropolitan-Vickers Long Service Association." The first of these was responded to by the managing director, Captain R. S. Hilton, who took the chair, and the second by Mr. S. Ratcliffe, J.P., one of the oldest employees of the company, and chairman of the Works Committee.

A humorous entertainment was provided by Mr. H. Ward, and a very enjoyable evening was spent, which concluded with the singing of "Auld Lang Syne."

Various Items.

Coal Mining.—A paper, entitled "Recent Electrical Developments in Coal Mining," will be read by Prof. Douglas Hay, at 3 p.m., on June 4, at the Mining Exhibition, which will be held at the Agricultural Hall from June 1 to 14.

Weather Forecasts.—From the 1st inst. telephone subscribers in this country are able to obtain weather forecasts from their telephone exchanges after 5 p.m. This arrangement has been made by the P.M.-G. with the Meteorological Department of the Air Ministry, and should prove of much value to many sections of the community.

More Motor Ships.—For the first time in two years Lloyd's Shipbuilding Returns (for the first three months of 1923) show an increase in tonnage under construction, compared with the previous quarter. This is, however, entirely due to the number of orders that have recently been placed for motor ships. It is stated in *The Motor Ship* that if all recent orders be taken into account the motor ships under construction in the United Kingdom total 253,000 tons gross, or nearly a quarter of the steam tonnage. It is satisfactory to note that Great Britain is well to the fore in this new development, and that nearly as many motor ships are being built in this country as in the whole of the rest of the world.

A Municipal News Service.—The Union Internationale des Villes (3 bis, rue de la Régence, Brussels) is now issuing six series of abstracts—the "Tablettes Documentaires Municipales"—of papers on various subjects appertaining to municipal engineering. The abstracts are derived from a great number of home and foreign publications and from 800 to 1,000 are given annually in each of the six series. In addition to subjects such as housing, water supply, public health, etc., the abstracts deal with lighting, heating, motive power and transport. Equipment, maintenance, statistics, operation, and law are all dealt with, and from the specimen abstracts now before us it is clear that the service rendered by the Union will be widely appreciated. The abstracts are in French, and the subscription is only 40 francs per series per annum (240 fr. per annum for the whole set). At the present rate of exchange this corresponds to six or eight abstracts a penny!

Electricity in the Garden.—Readers who are also gardening enthusiasts should read "Growing Crops and Plants by Electricity," by Dudgeon, price 1s. 8d. post free from this office. It contains much interesting matter on a subject which is attracting considerable attention at the present time.

E.D.A. Slogans.—The British Elecl. Developt. Assocn. write to say that applications for the printed conditions of the Slogan Competition should not be marked with the word "Slogan" on the envelope, as such communications will not be opened until the closing date of the competition. Envelopes containing actual attempts only should be so endorsed. Any reader having already applied for the conditions in a sealed envelope bearing the word "Slogan," should make further application to the E.D.A., 15, Savoy Street, Strand, W.C. 2.

Meetings.—The I.E.E. will meet on Thursday, 10th inst., at 6 p.m. Presentation of the Faraday Medal to the Hon. Sir Charles A. Parsons, and the fourteenth Kelvin lecture: "Problems in Telephony, Solved and Unsolved," by Dr. J. A. Fleming, F.R.S.——The Junior Inst. of Engineers will meet at 39, Victoria Street, S.W.1, on Friday, 4th inst. Lecturette: "A.C. Neutral Point Earthing," by S. A. Stigant (slides). Also, on Friday, 11th inst., Durham Bursar's Lecture: "The Theory of Resistance to the Flow of Gases and Fluids in Pipes," by W. F. C. Cooper, B.Sc. Both at 7.30 p.m.

The I.E.E. Journal.—The April issue of the journal contains reprints of papers on:—"The Maintenance of Voltage on a D.C. Distribution System by Means of a Fully Automatic Substation," by P. J. Robinson; "Some Problems in High-Speed Alternators and their Solution," by Rosen; "Directions for the Study of Pressboard for Electrical Insulating Purposes"; "The Measurement of the Electric Intensity of Received Radio Signals," by Hollingworth, which will interest wireless readers, and several valuable and up-to-date contributions, in all 100 pp., with many diagrams. The price is 10s. 6d., and it can be obtained from this office.

Personal.—We note that the winner of the first prize in the "All-Electric House" competition promoted by our contemporary, *The Electrician*, is Mr. Philippe Ernest Peronne, who is, we understand, in charge of the Sales Department of the well-known firm of Marryat and Place, 28, Hatton Garden, E.C.1. Mr. Peronne has been with this firm for some five years, three in a pre-war period. Previously he had a varied experience with several of the foremost British electrical manufacturing companies, both in this country and in various places abroad, after a technical training at Finsbury Technical College. He was born in London 34 years ago. In connection with the "All-Electric House" scheme, Mr. Peronne had the valuable assistance of Mr. C. J. Arden, a one-time apprentice of Marryat and Place.

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A PRACTICAL TRADE JOURNAL

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THE MAINTENANCE OF VOLTAGE ON A D.C. DISTRIBUTION SYSTEM BY MEANS OF A FULLY AUTOMATIC SUB-STATION.*

By P. J. Robinson.

Summary.

The paper describes the considered methods of meeting a particular case of voltage-drop in a large direct-current lighting network, and for bringing into use the maximum amount of its copper with a minimum of cost.

A fully automatic station was chosen in this instance for the reasons stated, and the author, in discussing the subject, has not attempted to review the relative merits of different types of automatic stations, but rather the method of dealing with a particular problem, and with this end in view has described the station which has come under his immediate control.

So far as the author is aware, the plant described is that of the first fully automatic station in this country, for any purpose, and of the first fully automatic station in existence operating a three-wire system.

The gradual growth and expansion of our cities owing to increased industrial activities and better transport facilities have brought large areas that were thinly populated suburbs into close touch with the city, and caused them to be more densely populated. This has meant that the original electric supply systems laid down, in some cases many years ago, have gradually extended until such time as the length of feeders has become troublesome owing to the voltage-drop.

In the event of the system being originally an alternating-current system and remaining so, this has been overcome by installing transformers at suitable points in the system to maintain the pressure. Where, however, the system was originally a direct-current one, the engineer was faced with a much more difficult problem, more particularly in the residential areas, as d.c. plant had to be installed, which meant buildings to house it and staff to operate it. The latter item is particularly expensive, as the stations are worked on a more or less low load factor; also the staff salaries and operating costs do not increase in direct proportion to the capacity of the station. This fact has led to larger and fewer sub-stations at long distances apart.

The more extensive use of domestic apparatus has had the effect of raising the average load taken by consumers from ½ kw. to 1 kw. for lighting, up to 5 or 6 kw. on the average when domestic apparatus, such as radiators, cookers, vacuum cleaners, irons, etc., has been installed. This has necessitated more feeding points along the system to make full use of the copper laid down. Assuming copper at 1,000 amperes per square inch, in some cases only 30 per cent. is available owing to the voltage-drop due to the length of feeders, which voltage-drop is, after all, the limiting factor in fixing the value of the distribution system.

The problem of maintaining a more constant voltage over the whole network, and at the same time keeping down operating costs and capital costs, has been exercising the minds of many electric supply engineers in this country, and Liverpool is in much the same position as other authorities. Recognising that the matter had to be dealt with, and appreciating the alternatives, i.e., to lay new feeders, or to change over sections of the distribution to a.c. supply, building up either a new distribution system or using old d.c. mains for a.c. supply (the latter being almost prohibitive, due to the cost of changing consumers' apparatus, motors, battery-charging sets, and many other pieces of apparatus not fitted with universal motors), it was finally decided to try to deal with the matter by installing fully automatically operated stations at different points of the system, thereby reducing operating costs to a minimum, and at the same time enabling the existing mains to be utilised to the best advantage.

Fully automatic control and remote automatic control of converter plant have been in use in America for lighting and traction purposes, and also in Switzerland for traction purposes, for some time past.

Remote control has also been in use in this country on several systems with more or less success, but British engineers appear to have fought shy of fully automatic control, and it has been left to Liverpool to lead the way in this direction. The Electric Supply Department decided that all conditions existing in Liverpool could be met by this control, and that, apart from periodical inspection of plant, operating labour could be eliminated.

Acting on this decision a general scheme was evolved for the control of a three-wire system with the conditions that would have to be met in Liverpool, also covering various points on which we must insist. Having chosen a site adjacent to Walton Town Hall, midway between two of our existing manually-operated sub-stations, namely, Cobbs Quarry and Rice Lane, we submitted the scheme to various manufacturers of automatic gear. The scheme and conditions were as follows :—

(1) The station to have a capacity of 500 kw., with room for extension.

(2) The station should cut in after the pressure on the low-tension feeder bars had fallen and

* Paper read before the I.E.E.

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remained low for a pre-determined time. (This time-lag was to avoid the station cutting-in with temporary falls in voltage.)

(3) The station should cut out after the current on the busbars had fallen and remained low at some fixed figure for a pre-determined time; the latter was to avoid the station cutting-out with temporary falls in load. This was also to enable the existing manually-operated stations to pick up the load when the conditions were such that the voltage could be maintained at normal.

(4) The station to operate plant running across a three-wire system, 230 volts between each outer and the neutral, and to maintain a balance in pressure.

(5) The station should operate in parallel with other stations, and other plant in the same station at a later date.

(6) If the load demanded due to existing manually-operated stations shutting down was greater than its capacity it should not cut in, and, if already running, the output should be limited to the capacity of the plant.

(7) In the event of a fault on either the negative or positive side of the system, the automatic switch controlling that particular circuit should operate to cut it out, without interference with any other circuit.

(8) In the event of a short-circuit on the outers of a feeder that feeder should be cut out without interference with any other circuit or the running of the plant generally.

(9) The middle wire of the system being earthed through a limiting resistance at the manually-operated stations, it was decided to deal with an earth fault from those stations.

The above conditions having been agreed upon, arrangements were made for dealing with them satisfactorily, and also to meet any difficulties due to faults on the plant itself or any connections therewith. It was then decided to proceed with a station equipped as follows :—

(1) One tap-started 500-kw. rotary converter (with brush-lifting gear) coupled through its transformer to the 6,000-volt, three-phase, 50-period supply on the one side, and on the other to a three-wire system with 460 volts across the outers and 230 volts to the middle wire, the latter being connected to a tapping on one leg of the transformer supplying the rotary converter.

(2a) One high-tension cubicle of moulded stone equipped with an electrically-operated oil switch with alternating-current closing coil; this switch to control the rotary converter.

(2b) Two liquid fuses to control the operating transformer (15 kva.) which supplies the operating coils on most of the relays and must therefore be permanently connected to the line.

(2c) One three-phase potential transformer for various instruments.

(2d) Necessary isolating switches.

(3) Low-tension d.c. panel for rotary converter, equipped with knife switches and electrically-operated contactors in the main circuit, with ammeters on each pole, a voltmeter, and field regulator.

(4) Low-tension feeder panels for control of four three-wire feeders, equipped with electrically-operated switches in the main circuit and knife switches in the operating circuit to control the main contactors in the event of a feeder requiring to be "laid off."

(5) Other panels to have mounted thereon numerous relays, devices and contactors, the description of which will be found in Appendix A, and the operation of which will now be described.

In the accompanying diagram the connections are arranged schematically, the numbers corresponding to the description and operation of the individual apparatus.

The automatic operation is started by means of a low-voltage d.c. relay (1), which operates to close its contacts when the voltage on the d.c. busbars drops to a pre-determined value due to the line voltage-drop consequent upon a certain demand for power. When the contacts of relays (1) are closed they insert, through an interlock on the main oil circuit-breaker (20), the operating coil of an a.c. voltage relay (2). This relay has a time-lag of a few seconds, and its function is to prevent the station starting due to a sudden drop in the d.c. network voltage, and also to prevent the station from starting when the a.c. voltage is abnormally low. When the contacts of relay (2) are closed they establish a circuit through the master relay (3a). The contacts of relay (3a) are then closed and complete a circuit through the operating coil of relay (3) which completes the closing circuit of (3a) to hold it in.

The contacts of relay (3a), when closed, also complete the circuit, through an interlock on the running contactor (11) of the operating coil of relay (31a), to cause its contacts to close and start the small motor of the brush-lifting device (31). This motor, by means of gears and a crank, raises the d.c. brushes from the commutator. When the brushes have been raised to the full extent, a throw-over switch operated by a crank disconnects the relay (31a) and thus de-energises the motor. The brushes now remain in the raised position until the circuit of (31a) is again completed by the closing of an auxiliary contact on (11), which closes when the contactor closes. This starts up the motor which actuates the crank to lower the brushes on to the commutator. The throw-over switch is returned to its original position by the crank, and is thus ready to repeat the above cycle of operations when the converter is again required to start.

In series with the operating coil of relay (3a) will be found the contacts of an overspeed device (24) and also a contact (7a) in the polarised motor relay. This contact (7a) is closed only when the relay is in correct working order and is placed in series with the coil of relay (3a) so as to ensure that, before the station can start, the operating element of the polarity relay is in the neutral position. Shunted across the coil of relay (3a) will be found the contacts of a number of protective devices.

Relay (18) is an induction-type polyphase voltage and reverse-phase relay. This relay, by short-circuit-

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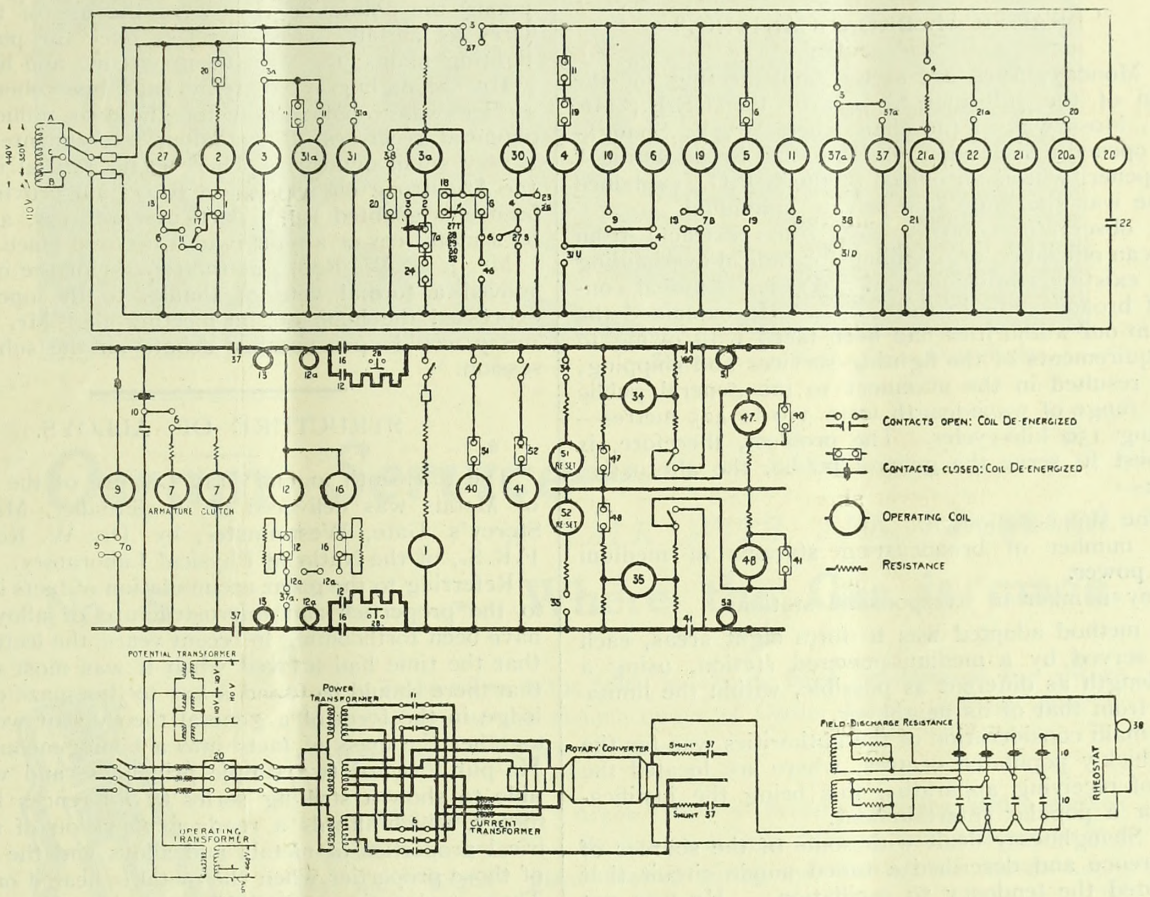
ing the operating coil of relay (3a), will prevent the starting of the converter if the phase rotation of the supply is reversed or if one phase of the supply is open. The remaining protective devices will be described later.

One main contact of relay (3) establishes the circuit for the main control busbar for the rest of the automatic apparatus. When the brush-lifting device is in the raised position it closes an auxiliary contact which completes the circuit, through interlocks on relay (19) and the running contactor (11) of the operating coil of a relay (4). One main contact of relay (4) completes the circuit of relay (21a), which in turn closes contactor (22). Contactor (22) completes the operating circuit for closing the oil circuit-breaker (20), an auxiliary contact on which makes a circuit through the low-voltage trip (20a) and also through the operating coil of the induction time-limit relay (21). Relay (21) has a short time-lag, at the end of which its contacts close and short-circuit the operating coil of relay (21a), thus causing the latter to open, which in turn opens contactor (22). The opening of contactor (22) breaks the circuit of the operating coil of the oil circuit-breaker (20), which is now held in the closed position by a mechanical latch.

The other main contact of relay (4) completes the operating-coil circuit of starting contactor (6), to cause the rotary converter to be connected across the starting taps of the transformer. The converter will now start to rotate, and when it is in phase with the supply the d.c. voltage will build up with either correct or incorrect polarity. This is indicated by the action of a polarised motor relay (7), which consists of a small armature mounted so that it can rotate between the poles of a fixed permanent magnet. The armature is energised from a pair of pilot brushes on the commutator, and thus its direction of rotation depends upon the polarity of the converter. Connected to the shaft of the armature through reducing gears and a clutch are two pairs of contacts, (7b) and (7d). If the polarity of the converter is reversed the armature will rotate and close contacts (7d), thus closing the field-reversing relay (9), which sets up its own hold-in circuit. The closing of the main contacts of relay (9) causes the operation of the field-reversing contactor (10). This contactor breaks up the converter field into two sections, connects them in parallel in the reverse direction, and thus causes the converter to slip one pole. When the converter has slipped one-half of the polar position the d.c. voltage falls to zero, and the field-reversing relay (9) opens. This allows the field contactor (10) to return to its original position, the converter then coming up with the correct polarity.

When the polarity is correct, the d.c. voltage will build up again and the polarised motor relay will rotate to close contacts (7b). When these contacts are closed they complete the circuit of the operating coil of the a.c. shunt relay (19), which makes its own hold-in circuit. An auxiliary contact on relay (19) opens the circuit of relay (4), thus causing all starting gear to be de-energised.

The main contact of relay (19) completes the circuit



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through an interlock on starting contactor (6) of the a.c. shunt relay (5), an auxiliary contact on which makes the battery circuit of the automatic voltage regulator. This relay (5) also makes the operating-coil circuit of the running contactor (11) which closes and connects the converter across the full voltage of the transformer secondary. The closing of running contactor (11) energises, through an auxiliary contact, relay (31a), which in turn starts the brush-lifting motor (31) to cause it to lower the brushes.

(To be continued.)

"PRACTICAL BROADCASTING."

On Monday, April 23, at the final meeting for the session of the Informal Section of the I.E.E., Mr. E. W. Moss was in the chair when Mr. E. Shaughnessy opened a discussion on "Practical Broadcasting." The opener, who is an official of the G.P.O., explained that he was speaking as a private individual.

His observations began with some extracts from American official reports, calling for radical overhauling of the existing confusion, and proposing national control of broadcasting in the U.S.A. He explained the problem our authorities had been faced with owing to the requirements of the fighting services and shipping, which resulted in the allotment to the general public of the range of wave-length from 350 to 425 metres—equalling 150 kilo-cycles. The problem, therefore, is how best to serve the general public, the alternative being:—

One super-station.
A number of broadcasting stations of medium power.
Any number of irresponsible stations.

The method adopted was to form eight areas, each to be served by a medium-powered station, using a wave-length as different as possible, within the limitations, from that of its neighbour.

The main consideration of the authorities was for the most thickly populated centres, where are located the mass of receiving apparatus, this being the justification for a popular entertainment.

Mr. Shaughnessy dealt with some of the sources of interference and described a tuned anode circuit that eliminated the tendency to oscillation. He was not hopeful of detecting the offenders, and appealed for honourable compliance with the regulations by the holders of experimental licences.

Captain Eckersley thought the wave band allotted was a very good one, but it has a most distinct shielding effect. At longer wave-lengths crystal sets would be less successful, but we are too considerate of the cheap apparatus and progress demands that we extend the wave. As microphones improve taste will expect clearer reception, and all tendency to oscillation will be dealt with.

Mr. J. Scott-Taggart thought the present conditions too irksome for the experimenter and amateur enthusiast. If the public are to be satisfied they should be able to switch over to the different stations and select their programme.

Mr. W. D. Dewar pointed out that French ships in the Channel, working at about 300 metres wave-length during the time of 2LO transmission, caused much interference.

Mr. P. R. Coursey agreed that the average receiver wants to be able to select his programme, and thought the chief obstacle is that stations are too powerful—if you live well out you have a better chance of picking up a variety of stations. He thought that instead of catering for the cheapest form of apparatus it would be better to encourage best apparatus. There are no doubt amateur experimenters who are a nuisance, but many are doing much useful work.

Messrs. E. G. Bedford, J. R. Bedford, W. Day, R. Grierson, E. F. Hetherington, A. G. Lee, W. H. Lawes, E. W. Moss, H. S. Pocock, A. C. Warren, W. E. Warrilow and W. L. Wreford also spoke, and among the points debated were the use of telephone wires as aerials, wired wireless over the power and lighting mains, the Armstrong circuit, and licences.

Mr. Shaughnessy in reply said his conception of service was consideration for the two million or so potential receivers—the amateur experimenter was in a very small minority. There is no refusal to license the Armstrong circuit subject to certain provisions. A licence is granted for a particular address, and a set on a motor-car or a punt is in a licensed place.

Mr. J. G. W. Reith, at the request of the chairman, moved a formal vote of thanks to the opener, and expressed the hope of the meeting that Mr. Shaughnessy would open another debate on the subject next session.

STRUCTURE OF ALLOYS.

The thirteenth annual May Lecture of the Institute of Metals was delivered on Wednesday, May 2, at Storey's Gate, Westminster, by Dr. W. Rosenhain, F.R.S., of the National Physical Laboratory.

Referring to the great accumulation of facts in regard to the properties and microstructure of alloys which have been forthcoming in recent years, the lecturer said that the time had arrived when it was most desirable that there should be found a key to this maze of knowledge in the form of a general theory that would link together the mass of facts into a homogeneous whole. He put forward two simple principles, and was then able to show a striking series of inferences from his theory, which affords a ready explanation of the electrical properties of metals and alloys and the changes of those properties when the metal is heated or cooled. These explanations cover the mysterious phenomena of super-conductivity found in many metals when cooled nearly to the absolute zero of temperature.

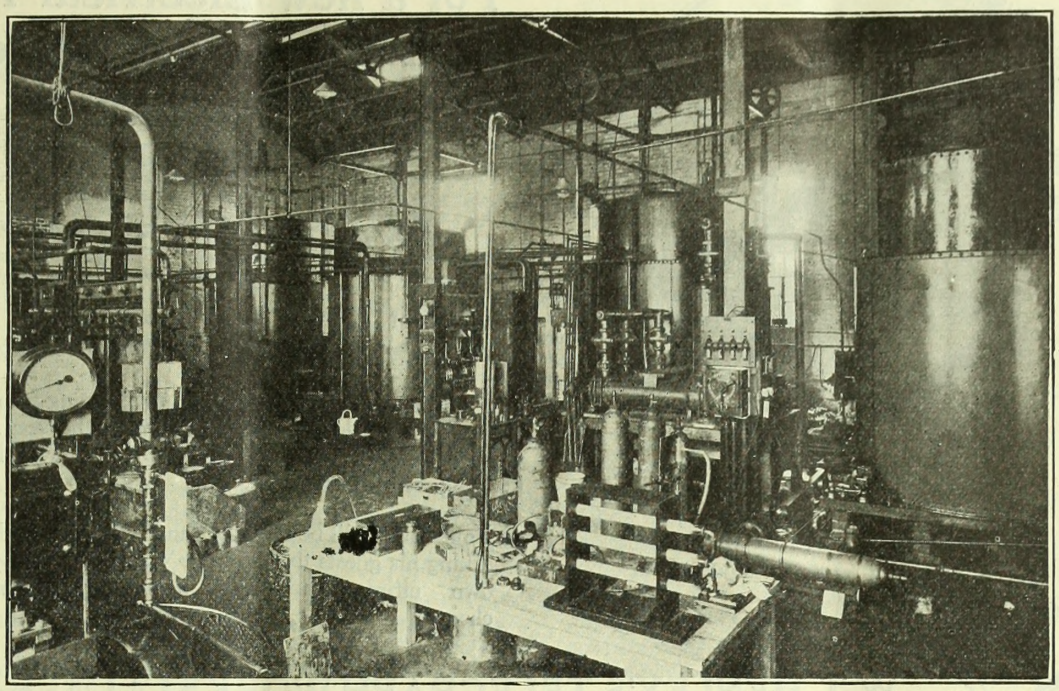
A LARGE WIRELESS DEMONSTRATION.

A demonstration of "Gecophones" was recently organised by the General Electric Co., Ltd., at Magnet House, Kingsway, on the occasion of the broadcasting of the pantomime "Cinderella."

Five inside aerials were erected in the lecture hall, and to these as well as to a number of electric light attachments were connected 36 "Gecophone" receiving sets, including 2-valve sets and the No. 1 and No. 2 crystal sets. To these sets were connected, in all, some 150 pairs of double headgear telephone receivers, together with additional loud-speaker equipment.

The loud speaker was in operation during intervals in the programme, and a large number of the company's trade friends were able to compare results obtainable with the various types of apparatus.

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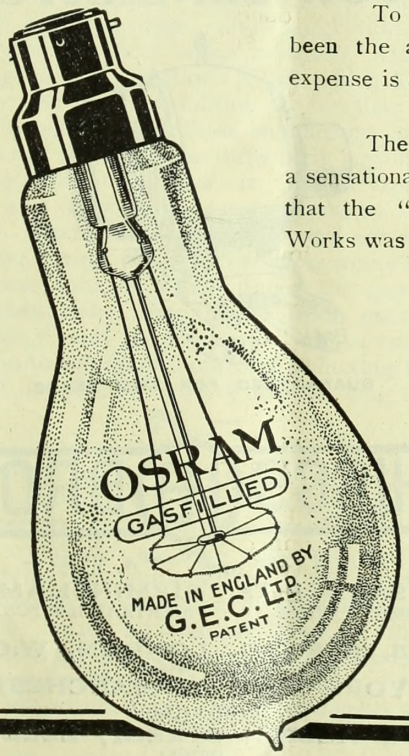


The Argon Gas Plant. Osram Lamp Works.

Osram Service—

A TALK WITH THE RE-SELLER.

No. 5 - - - Where the Gas is made.



To be "first in the field" in electric lamp development has always been the aim of the manufacturers of Osram lamps, and no effort or expense is spared in this direction.

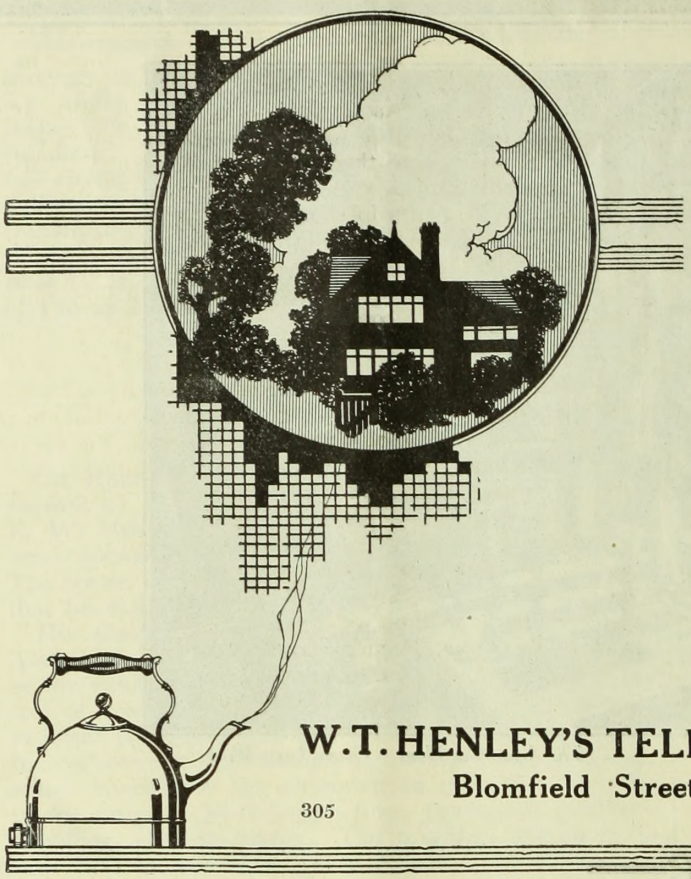
The inert gas "Argon" was a British discovery which marked a sensational advance in the art of electric lighting, and it is noteworthy that the "Argon" plant erected during the War at the Osram Lamp Works was the first of its kind in this country.

Osram
G.E.C.

GASFILLED LAMPS.

Advt. of The General Electric Co., Ltd., Magnet House, Kingsway, W.C.2.

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For a new Electrical Installation or an extension

there is nothing so easy as the

HENLEY
Wiring System

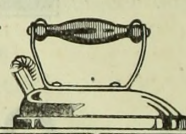
whether from a steel barrel, casing and capping, or an existing H.W.S. installation.

It can be run along the top of the skirting board to the plug, so closely that it can scarcely be seen. If it is painted to match the skirting board it looks like part of the beading.

Your client will be delighted and will take pride in asking his guests to "find the wiring"——to your own ultimate advantage in new recommended clients.

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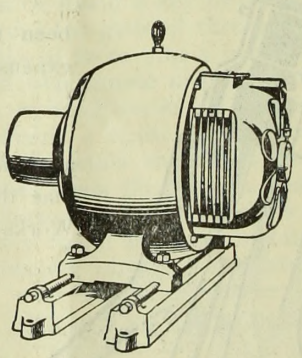
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TO OUR READERS.

ELECTRICITY is published every Friday, and, if ordered, is on sale at the principal Railway Station Bookstalls and Newsagents on that day. It has a very large sale throughout the United Kingdom, as well as in the British Colonies and Abroad.

New advertisements for the displayed columns and alterations to existing ones must reach the publishing office not later than first post Tuesday morning, in order to be in time for the issue of the following Friday. This is important. Rate quoted on application. Subscription: 13s. a year, 6s. 6d. half year, 3s. 3d. a quarter in advance, postage prepaid in the United Kingdom and abroad.

Questions to which an answer is required must be accompanied by a 1½d. stamp for reply. When considered of sufficient interest, the answer will probably appear in the paper.

All remittances payable to the Publishers, S. RENTELL AND CO., LTD., 36-39, Maiden Lane, London, W.C.2. Telephone No. 2460 Gerrard.

Current Topics.

A Sane Policy.

Hearty congratulations to the National Electrical Contractors' Trading Association upon its public expression of a policy which it considers should be adopted throughout the electrical industry. Whether, having regard to the present state of the industry, their policy savours too much of idealism or whether it will ultimately prove a practicable proposition remains to be seen, but in any event, to the N.E.C.T.A. belongs the credit of having laid down the fundamental principles of electrical trading for the criticism or adoption of others. It is an unfortunate fact that the electrical industry is at present one of the worst organised industries extant. Rules and regulations which are meticulously observed in other trades are more honoured in the breach than the observance by the electrical fraternity, and it is no libel to state that the standard of business morality in some electrical trading circles is very low.

In the general trading policy outlined by the Special Policy Committee of the N.E.C.T.A. the present vexed relationship between manufacturer, wholesaler and retailer is made clear, and suggestions offered for putting the electrical house in order. Among the outstanding recommendations is one which aims at reducing the costs of distribution to the user of electrical goods by eliminating those middlemen or wholesalers who do not genuinely perform their legitimate function in the distributing chain, viz., by carrying substantial stocks and supporting manufacturers by large contract buying. There is very pressing need for reform in this direction; during the past few years many smaller firms have come into existence under the general title of wholesalers, who nevertheless trade mainly on retail lines, carry next to no stocks, and simply pass their orders on to the manufacturers, deducting a substantial discount for which they have done nothing to qualify.

Such firms are in truth parasites; they do not exist for the benefit of the industry; they take little or no risk, and for the quantities in which they deal the retailer could just as well and more profitably trade directly with the manufacturer. Undoubtedly the latter would suuport the extinction or elimination of this class, since they exact all the privileges of the wholesale trader without yielding commensurate service or support to the manufacturer as bulk distributors of his products. Similar arguments apply in a lesser degree to the recommendation which urges that contractors and retailers shall reduce costs by buying in quantity. Since he is in direct touch with the user, the function of the retailer is not only to supply his customers with what they ask for, but also to play his part in introducing new commodities to their notice and educating them up to the advantages of new designs, etc. If he simply follows the first principle and does not lay himself out to create new markets all the time, then he also is not doing his share in the general scheme of distribution and is obviously only able to buy in small lots and at maximum overhead cost.

A subsequent recommendation, following naturally on the development of the one just outlined, aims at the discouragement of manufacturers and wholesalers from direct trading with users until eventually, when the contractor and retailer are indeed performing their true function in the distribution train, it will only remain for the manufacturer and wholesaler to advertise their goods and thus create a demand which it will rest with the retailers to satisfy. An immediate policy of the Association is to limit as far as possible the conditions under which manufacturer and wholesaler may supply direct to the user, and where it agrees *pro tem* to the continuation of this practice the price to the user for any article is to be such as to allow any retailer to execute the order on the same terms whilst reserving for his services a reasonable margin of profit.

With regard to discounts, the Committee also make themselves very clear. To eliminate the wasteful practice of small parcel buying they suggest that quantity discount be based upon (a) Quantity of any single order, and (b) Quantity taken in a stated period, the discount under (a) to be generally larger than that under (b). They might have gone a step further and recommended that discounts under (b) should preferably be allowed by way of a rebate at the end of the stated period rather than on individual transactions, since it is the practice of some unprincipled traders freely to subscribe to the discount terms offered to them without any real intention of living up to the spirit of the arrangement. Such cases would be automatically penalised by the withholding of any rebate until it had been legitimately earned.

Very clear definitions are given of the terms "Electrical Wholesaler," "Wholesale Trade," "Retail Trade," "Electrical Contractor," and "Electrical Retailer." If the definitions given were strictly observed the industry would unquestionably be purged of a considerable and wholly undesirable element which is at present battening on the user of electrical goods and the consumer of electricity. Support home industries is the basic principle of the last recommendation, which stipulates that the Association shall support British industry and give preference in its agreements to British Manufacturers and Wholesalers of British goods. I strongly commend these recommendations to the close attention of all readers who have the welfare of our industry at heart. Be he manufacturer, wholesaler or retailer and contractor, provided he is a legitimate trader possessing the necessary qualifications, their eventual adoption cannot but benefit him individually in the long run.

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Loud Speakers and Crowds.

The recent fiasco at the Stadium, when an unprecedented Cup Final crowd got out of control, prompts the suggestion that we might adopt the American system for dealing with similar large public gatherings with advantage. Large crowds, taken *en masse* are brainless, and like sheep without a leader. The individual units of such a crowd nevertheless possess brains and are quite capable of using them in emergency if capably directed by some authoritative head. With such a huge mass of human beings as that which assembled at the Stadium, however, it is impossible for an individual director or even a small army of officials to get into audible touch with the various sections of the crowd and make themselves heard.

In its present stage of development the loud speaking receiver, as designed and so largely used in connection with the reception of broadcasting, offers a solution of the difficulty, for a number of these devices can be fixed at appropriate spots each within hearing of a section of the assembled multitude, and each conveying its common or associated message to those whose ears it is intended to reach. Had such an installation been available at Wembley it is highly probable that the unfortunate contretemps which was reported in the Press would never have reached such a stage of hopeless confusion. The necessary orders could have been broadcasted from a central observation point and the moving mass of people controlled to an extent which was impracticable by direct police supervision. This suggestion savours of shutting the stable door after the disappearance of the horse, but to my mind the idea is well worth a trial on some subsequent occasion when large attendances may confidently be anticipated at the Stadium or any other popular centre of recreation or amusement.

The Press and Industry.

The valuable work that the Industrial League and Council is doing to promote better relations between Capital and Labour deserves to be more widely known. In these days, when these two sections of the community are represented by powerful organised bodies, adopting an unduly partisan attitude, any well-directed effort at bridging the gap between the employer and the worker is welcome. The timely address given by Mr. G. J. Wardle before the Circle of Scientific, Technical and Trade Journalists on May 1 was not only a summary of the ideals of the League, but an appeal to journalists to use their influence in the right direction. Some journals can take an entirely impartial view, and their influence is very valuable.

Others represent trade interests, and naturally voice the views of their supporters. But even in this case they should try to be fair, to allow for the point of view of others even when they do not share it, and to use their influence to smooth away differences and not accentuate them. As Mr. Wardle truly remarked, neither Capital nor Labour can impose their will on the community. As separate and warring factions they can achieve little; but with good will they can solve together even the complex industrial difficulties that confront us to-day.

Coal.

I notice with keen regret that the leaders in the Miners' Federation are still resolutely opposed to a return to the eight-hour day, although it would help materially to remove the troubles from which coal mining in this country is suffering so severely. The union auditors have examined the colliery accounts so closely that they practically agree with the figures submitted by the owners, and the men know full well that cheaper fuel would go still further to assist the great iron, steel and engineering industries of the country in their quiet but steady revival. Will the mining leaders help and vote for the eight-hour day? Not a bit. It would really mean more money for them and more trade for the whole country, which would represent a further drop in certain important items in the "cost of living," but, to use the words of one of their very able leaders, they are "still obstinate," and say in effect that they don't care a cuss for the good of the country as a whole.

Such a line of policy is greatly to be regretted, because, with the exception of the shirkers, who rushed into the collieries to avoid joining up during the war, the miners of Great Britain have ever proved themselves a most patriotic body of men. In fact, the way in which the old originals flocked to the Colours in 1914 was simply astounding, and will ever be remembered to their credit. Now they are dropping away from their union at a rate which is causing serious concern to their leaders, and it looks as if many of the men would be quite willing to work the eight hours if they were assured that in the long run it would mean more money or cheaper living. A reduction in the cost of coal would mean reductions in the charges for electric light and power, and this again would help to reduce manufacturing costs in many directions, quite apart from the impetus it would give to the demand for electrical apparatus to be fitted up by electrical contractors, who would be only too glad to employ more labour on installation work. I hope, therefore, that by mutual arrangement between masters and men application will be made for the Act to be repealed, or so amended as to avoid the present handicap to a great national industry.

ELEKTRON.

Answers to Correspondents.

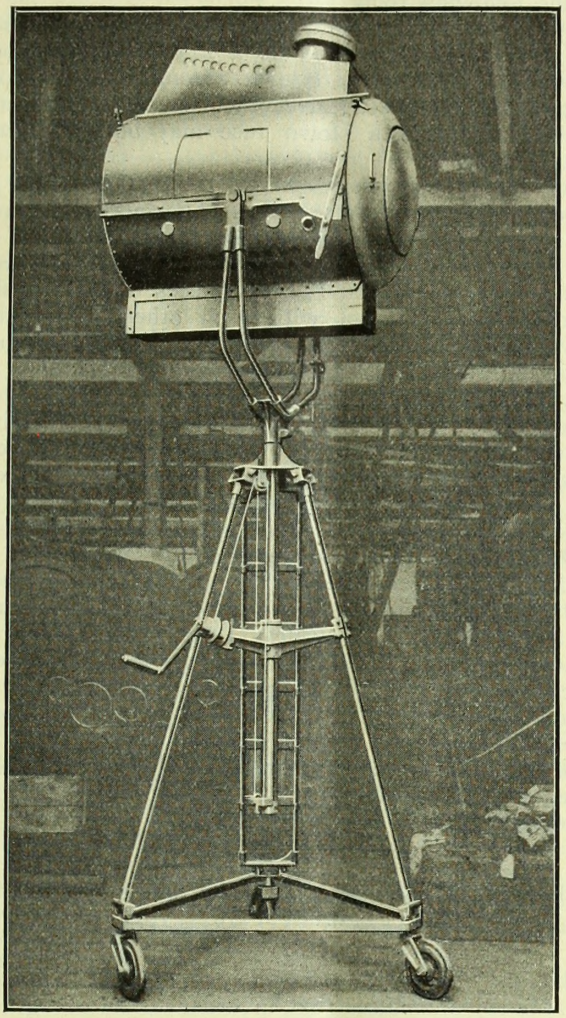
SUSSEX READER.—We are under the impression that the "Rye Hill" to which you refer is used merely as an attempt to key the pulling power of a particular newspaper advt. The original Rye Hill is the main London road just where it leaves the old town of Rye in Sussex, and is probably centuries older than any other road or address so named. The town was ancient before the Norman Conquest, and in the early Middle Ages was one of the great ports of England.—EDITOR, ELECTRICITY.

The I.E.E. (Wireless Section).—Mr. C. F. Elwell, Prof. G. W. O. Howe, Admiral Sir H B. Jackson, and Mr. C. F. Trippe have been nominated to serve on the Committee for 1923-24, and the following will continue to serve as members, viz.: Messrs. B. Binyon, S. Brydon, Dr. W. H. Eccles, Messrs. G. H. Nash, C. C. Paterson, J. St. Vincent Pletts, Capt H. R. Sankey, and Mr. R. L. Smith-Rose.

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CINEMA STUDIO LIGHTING.

The accompanying illustration shows the portable 24-in. cinema studio projector made by the London Electric Firm (Brighton Road, Croydon) for concentrated, diffused and wide-angle lighting.



The lantern may be mounted on an extensible tripod stand having large castor wheels, as shown. Swivelling and tilting movements are provided, and a convenient door is fitted to the operating side of the lantern, together with an observation window. An alternative method is to fit the projector on a short base and mount it on the platform of an extension ladder or tower.

The lamp is of the firm's patented automatic "non-disengaging" feed pattern, but it can be hand-fed if required, the feed wheels being brought outside the lantern, and so provide for easy and quick operation. The positive carbon rotates automatically as long as the lamp is burning, and thus preserves a perfect crater "formation."

For concentrated light effects a silvered glass mirror is fitted to the rear of the lantern, and the front may be furnished with a plain glass. For softening down a diffuser is provided.

The illuminated area may be increased or curtailed by adjusting the position of the lamp in relation to the mirror, and a simple focus gear is fitted to facilitate this.

There is also a special provision for obtaining a clear and unobscured wide-angle floodlight. It will be seen that the projector has a second aperture (above the front and main aperture), and the mirror is arranged to tilt so that the light may be projected through the smaller opening, converging towards this from the mirror, and thereafter diverging to a considerable (and variable) angle, thus giving a large uniformly illuminated field. A diffuser can also be fitted to soften the effect. Either or both of the front openings can be furnished with Iris shutters or other controlling device, as may be required.

The frame holding the mirror is made removable, so that the light direct from the arc may be used.

Questions and Answers by Practical Men.

RULES.

QUESTIONS: *We invite our readers to send us questions, preferably on technical problems that have arisen in actual practice. Questions which we consider of sufficient interest to our readers will either be replied to under "Answers to Correspondents" or replies will be invited from our readers. One shilling will be paid for the question which we select for competitive replies in this column.*

ANSWERS: *A fee of 10s. will be paid for the answer which we consider shows the greatest merit, and 5s. for the one we select as second best. In judging the replies, importance will be attached to clearness and conciseness, as well as accuracy. The Editor reserves the right to make no award, or to accept only one reply, if, in his opinion, the answers received do not possess sufficient merit. Competitors desiring the return of their manuscripts, if unaccepted, should enclose stamped addressed envelope.*

Write on one side of the paper only, and if diagrams are sent, draw them on a separate sheet of paper attached to the manuscript. Competitors may adopt a "nom de plume," but, both in the case of questions and answers, the competitor's real name and address must be sent with the manuscript as a guarantee of good faith. No correspondence will be entered into with regard to successful replies. The Editor's decision is final.

Commencing with Question No. 101, a Diploma of Merit will be awarded to the six competitors who win the first or second prize the most times during the next twelve months.

The words "Questions and Answers" or "Q" and "A" should be placed at the top left-hand corner of all letters intended for this column.

QUESTION NO. 159.

I wish to decrease the speed of a direct current motor under my charge. I desire to do this without the insertion of resistances, which I understand are very wasteful. How can I most efficiently do this? The motor is 40 h.p., 220 volts, compound wound.—"INSPECTOR."

QUESTION NO. 160.

When looking through an old book on cable laying I came across the expression "cable should be taken from the drum and laid in a figure of eight upon the ground before being drawn into the duct." Can any reader tell me why this should be, because the book does not tell me why?—"JOINTER."

(Replies to Questions 159 and 160 must be received not later than May 26, 1923.)

Answers to Questions.

QUESTION NO. 155.

Can anyone give me details which govern the selection of a fuse carrier? I desire some for use on the following service:—Volts 440 D.C., 50 amperes, three wire.—"Cable."

REPLY TO QUESTION NO. 155.

The first prize (10s.) has been awarded to "L. R." for the following reply:—

The chief characteristics required in a fuse carrier for a 440-volt circuit are, in addition to the usual electrical requirements of capability of withstanding a suitable puncture pressure and flash-over voltage, ample

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ventilation, complete protection from shock and compliance with the official or Home Office Regulations. The circuit is not a high voltage circuit according to modern experience, low tension fuses being commonly specified for circuits even up to 600-650 volts. The current of 50 amperes is not unduly high for a fuse because these may safely be employed on a circuit of the voltage indicated for currents amounting to, say, 200 amperes.

The carriers should be non-hygroscopic and not likely to be changed in physical or chemical characteristics, either through electric stresses or any chemical action resulting therefrom. Although from the point of view of commercial manufacture 440 volts is regarded as a low pressure, the electricity regulations for factories and workshops define it as within the range of medium pressures, but even under that definition similar remarks apply. It is not until one reaches a pressure of 650 volts or thereabouts that high tension factors come into consideration.

Official regulations require that every fuse shall be so constructed and arranged as effectively to interrupt the current before it so exceeds the working rate as to involve danger. It shall be of such construction or be so guarded or placed as to prevent danger from overheating or from arcing or the scattering of hot metal or other substance when it comes into operation, and shall either be of such construction or so protected by a switch that the fusible metal may be readily renewed without danger. It must be so constructed and adjusted as accurately to make and to maintain good contact, be provided with an efficient means of working or handle insulated from the system and so arranged that the hand cannot inadvertently touch live metal.

Open fuses should never be used in metallic cases. Only the cartridge type of fuse is suitable for this purpose, and even with that form the lack of ventilation causes an increase in the temperature rise of the fuse, so that the next larger size of cartridge should be employed to ensure safety.

Some fuses are fitted with magnetic blow-outs, but this should not be required for a pressure and load of the order referred to above.

Fuses may be mounted on slate bases for that kind of pressure and loading, space being allowed above the fuse and in other directions of sufficient amount to allow the arc on fusion to break without touching metal, and busbars carrying large currents should be kept away from the fuse.

In one favoured form of construction, the carriers for the fuse wires comprise an asbestos tube which passes through a tubular handle of special insulating material. At each end of the handle there is fixed a metal contact tongue, to which the fuse wires are attached by bolts. The contact tongues engage with contacts which are mounted in housings of insulated material so shaped that when the fuse handle is inserted no live metal is exposed. The fuses are provided with back connections so that they can be mounted on slate or marble panels, which are commonly from 1 in. to 2 in. thick, but they may be modified for front connections to panels.

For a circuit as described such a fuse carrier would be about 6⅓ in. long and would extend about 2½ in. forwards from the base plate. The distance between the centres of its contacts should be about 4½ in. and the width of the contacts 2 in.

A fuse wire, commonly known as a 60-ampere size, is required, and this could be formed of tin copper fuse wire, two wires each of No. 19 S.W.G. being employed. These would blow at approximately 125 amperes, which is about the proper figure for carrying a current of 50 amperes.—" L. R."

The second prize (5s.) has been awarded to " M. M." for the following reply:—

The three principal points to be taken into consideration are: That there shall be a satisfactory distance between the terminals in order to minimise danger from arcing; that the electrical contacts shall be good and reliable; and that a blown fuse may be easily and cheaply replaced.

For the first of these points the distance, for 50 amperes, should not be less than 3½ inches; as regards the second, the contacts should not only be ample in area, but should also be laminated, springy and well fitted. It is rarely that two flat pieces of metal make good electrical contact with each other. The third point, facility of replacement, is all important. When a man is fitting a new fuse he usually wants things as convenient as possible.

Personally, the writer prefers those carriers having a grip for withdrawal. Tinned copper wire is very suitable for fuses; blown fuses are readily replaced, and the material is usually at hand. For the fuses in question No. 20 S.W.G. would make normal fuses.

Other details that deserve attention are quality of workmanship, convenience for fixing and general protection against fire. " Crazy " porcelain is an objection. Cartridge fuses have much to recommend them, but they are often absent when very much wanted; many cartridge cases will be found on examination, when they have been in use for some time, to be carrying a simple copper wire.

It should be remembered that the third wire is only fused when it ceases to be a neutral; while neutral it is provided with a link.—" M. M."

ELECTRICAL STORAGE BATTERY LOCOMOTIVE COMPETITION FOR £1,000 PRIZE.

Lieut.-Col. G. R. Lane-Fox, M.P., the Secretary for Mines, announces that in order to encourage the production of a safe and efficient type of electrical storage battery locomotive for use underground in coal mines, and with a view to displacing pit ponies in deep and hot mines, Mr. Charles Markham, colliery director, of Ringwood Hall, Chesterfield, has placed at his disposal the sum of £1,000 to be offered as a prize for the best vehicle. Judges representative of the coal mining industry of Great Britain, the Institutions of Mining and Electrical Engineers, and the Mines Department have been appointed to lay down the conditions under which the competition is to be conducted and to adjudicate upon the merits of competing designs.

The competition will be open to manufacturers of any nationality, and the competition will remain open for an adequate period to allow competitors in foreign countries and the Dominions to submit their designs. Working trials, in England, will subsequently be arranged of those vehicles selected for test.

The preliminary details in connection with the competition are approaching completion, and a formal announcement will shortly be made of the conditions.

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SOUTH AFRICAN ELECTRICITY ACT.

The Electricity Supply Commission provided for under this Act has now been appointed and, so far, its functions have been exercised by a board of officials appointed as a separate body under the Act to supervise the issue of licences on the basis adopted by the Transvaal some years ago. The first meeting will be held at an early date, and among the first points to be considered are:—(1) The taking over from the South African Railways of the great power station in course of construction at Colenso; (2) the erection of a power station at Durban; (3) the provision of electric power in the neighbourhood of the Sabie Goldfields, Transvaal; and (4) the erection of a power station at Witbank.

Correspondence.

PATENTS IN THE IRISH FREE STATE.

To the Editor of ELECTRICITY.

SIR,—I beg to inform you that special information has been received by this Institute in connection with patents in the Irish Free State.

I shall be pleased to supply this information to any of your readers, on application to me at 44, Great Russell Street, London, W.C.1.—Yours faithfully,

G. DRURY COLEMAN,
Organising Secretary,
May 2, 1923. Institute of Patentees (Inc.).

"WHAT'S WANTED."

To the Editor of ELECTRICITY.

SIR,—I beg to inform you that the Rt. Hon. Sir William Bull, Bart., M.P., has presented this Institute with a book entitled "What's Wanted," and he has opened the book by entering what, in his opinion, are the inventions which are needed most at the present time.

I shall be pleased to receive, on behalf of the Council, any suggestions which your readers may care to put forward for record in the book.

I might add that Sir William Bull is an honorary vice-president of this Association.—Yours faithfully,

G. DRURY COLEMAN,
Organising Secretary,
Institute of Patentees (Inc.).
44, Great Russell Street,
London W.C.1.
May 3, 1923.

Reviews of Books, &c.

[Books noticed in this column will be sent from ELECTRICITY Office to any part of the world, for the published price, plus ten per cent. for postage (minimum 2d.) and orders will be appreciated.]

LONDON'S COUNTRY. 2 vols. Guide No. 1, North of the Thames; No. 2, South of the Thames. (Larby, 1s. each net.)—All true Cockneys are proud of their great city and the lovely country by which it is surrounded, and the controlling spirits of that great organisation known as "London's Underground" are to be congratulated most cordially on producing two such excellent guide books. They cover the districts north and south of the Thames in a very comprehensive manner, while the maps are numerous and models of clearness. In addition, there are many well-printed illustrations of the favourite beauty spots to which easy access may be obtained by the tubes, trams and 'buses under the control of the Underground Electric Railways and their associated companies. Let us hope they will help many a tired worker to obtain that rest and invigorating breath of fresh air which should help to fight the battle of life in these strenuous times.

B.E.S.A. PUBLICATION NO. 148, 1923.—A tentative British Specification for Insulating Oils for use in Transformers, Oil Switches and Circuit Breakers (Publication No. 148, 1923) has just been issued by the British Engineering Standards Assocn. It is the outcome of an extensive research undertaken in the first instance by the Research Committee of the I.E.E., and continued by the Electrical Research Assocn. when that body was formed. The Association has issued this as a tentative specification in the first instance, as the methods of conducting the tests are at present undergoing further investigation, every effort being made to simplify the latter as much as possible. The Inst. of Petroleum Technologists is also preparing methods of testing oils for the ordinary physical properties, such as viscosity, flash point, etc., which it is hoped will be available for use in connection with this specification. This is the first B.E.S.A. specification based on the work of the British Electrical and Allied Industries Research Assocn., and illustrates the very great value of such a body to the industry. Copies may be obtained from the offices of the B.E.S.A., 28, Victoria St., London, S.W.1, price 1s. 2d. post free, or from ELECTRICITY office.

THE B.A.T.T.J. OFFICIAL HANDBOOK. (1s. net.)—This little handbook, which is published annually by the British Association of Trade and Technical Journals, of Sicilian House, Southampton Row, London, W.C.1, contains a neatly printed list of all the journals which are members of this very enterprising association, together with details as to the ground which each paper claims to cover and of the advert. rates charged. It may, therefore, be looked upon as an essential to every large advertising firm, and we have no doubt that the book will be much appreciated. As a matter of fact, from a business standpoint it represents many times the value of the small price which is asked for it.

PRACTICAL ELECTRIC LIGHT FITTING. By Allsop. 9th edition. (Pitman, 7s. 6d. net.)—Mr. Allsop's book has been on the market for many years, and every new edition has helped to instruct a large number of budding electrical engineers and contractors in the correct way in which practical electrical installation work should be carried out so as to comply with the Institution Wiring Rules and maintain the reputation of the contractor for honest work at a fair price. The book has been improved by the inclusion of details of various new wiring systems, the most modern types of testing sets, electricity meters and a comprehensive general chapter on the erection and maintenance of private installation plant. There are plenty of good clear diagrams, and the book is certain to be appreciated by all who buy it. The author has done his work conscientiously and well.

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Trade Notes.

Messrs. Eck and Brook, the well-known electrical and radio engineers, of 4/12, Palmer Street, London, S.W.1, are circularising possible clients with a view to the installation of wireless receiving sets for reference purposes, and will be glad to have inquiries from interested readers or to have them call at their showrooms.

From **A. H. Hunt, Ltd.**, of Tunstall Road, Croydon, come leaflets Nos. 140 and 141 dealing with a valve protector and battery tester and a variable grid leak, both of which will be of interest to wireless readers, whom we recommend to apply for copies.

From **Simplex Conduits, Ltd.**, of Garrison Lane, Birmingham, we have received list No. 974, which is a revised edition of their Colliery Lighting System Booklet. This system is one which has been received with much favour by the leading collieries in Great Britain, as well as in the British Colonies, and we can recommend it to the notice of our many readers who are engaged in colliery and mining installation work, as well as to contractors generally. It has proved adequate to the most severe conditions, and since its introduction in 1921 many thousands of its fittings have been installed in mines throughout the world.

We have received from **Messrs. Radiophones, Ltd.**, 1a, Granville Place, Marble Arch. London, W.1, an illustrated brochure descriptive of their Listoleon Radiophone De Luxe Cabinet. This set has been designed to meet the demand for a highly-efficient and easily-manipulated installation among those whose knowledge of the science of wireless telephony is nil, and the whole of the essentials, including a loud speaker, are enclosed in an attractive cabinet of polished mahogany, which is in itself a handsome addition to the furniture in any room in which it may be housed.

Messrs. Rogers, Foster and Howell, Ltd., Edward Road, Balsall Heath, Birmingham, whose R.F.H. Wireless Broadcasting specialities are already well known to both amateurs and the trade, have favoured us with their latest catalogue, the outstanding feature of which are the references to their new Reaction sets, in which beneficial reaction has been introduced to the limits permitted under the Broadcasting regulations. With their 2-Valve Reaction sets the makers claim some remarkable reception ranges, and, by the addition of a third valve, the use of a loud speaker is facilitated in practically every case. The distances from the transmitting stations vary from a minimum of three miles up to a maximum of 630, in the case of one German station, and it is claimed that these are by no means freak receptions, but represent regular tests made upon the apparatus before it leaves their works. The new catalogue is a particularly comprehensive one of some twenty pages, and includes all essential components in considerable variety. It is fully illustrated.

A well printed catalogue of outdoor switchgear has just been issued by **Messrs. Johnson and Phillips, Ltd.**, of Charlton, S.E.7. It gives an excellent series of illustrations, together with full details of the lightning arresters, outdoor type fuses, automatic switches, choke coils, gap arresters and fuses suitable for outdoor installations, in which economy of erection, combined with absolute security, are the essential features of the overhead line plant. Messrs. Johnson and Phillips have had very wide experience in the design and construction of this particular class of material, which can be recommended most cordially for the extension of electricity supply into the thinly-populated areas. The list, therefore, will appeal to all central station engineers, and contractors who wish to cater for this particular class of installation work.

We have to congratulate the **Western Electric Company, Ltd.**, upon setting a new fashion in that portion of the broadcast receiving installation known as the loud speaker. Most listeners-in aspire, sooner or later, to a loud speaker, and practically all these instruments take the general form of a base, containing the telephone receiver mechanism, surmounted by a horn or sound amplifier, similar to that fitted to the ubiquitous gramophone. Realising that these horns or trumpets are not altogether things of beauty, and therefore apt to detract from the furnishing and decorations of the room in which they are used, the Western Electric Company have introduced a scheme of decoration, and issue an artistic brochure with illustrations in colour, under the title "Ornamental Loud Speakers." The designs range from Chinese Pagoda, and Peacock, to Floral embellishment, and include both the horn proper and the base. They are certainly attractive, and are excellently presented in the new publication, which, moreover, is printed in a special and extremely clear fount of type.

From **Garquarm Specialities**, Aversroyd, Golcar, Huddersfield, comes a folder descriptive of the "Merican" Atmospherics Absorber, for which, as its name implies, is claimed the property of eliminating those static disturbances which are the bane of the broadcast listener-in. It functions on a new principle of multi-cylinders and static storage plates, with special variable coupling. Not having had an opportunity of trying out this device, we cannot vouch for its efficacy. The price is, however, moderate. The folder also gives prices of several other wireless components.

From **Higgs Bros.**, of Sand Pits, Birmingham, whose name is so well known to our readers through their humorous monthly price list, we have received a copy of their new list No. 8, which they have just issued. It covers a wide range of dynamos and motors, including variable voltage dynamos, and as the manufactures of this firm hold a very high reputation for quality and efficiency, we have no doubt they will have a large number of applications for copies of the new list, which should most certainly be in the possession of every electrical contractor and engineer.

A printed card illustrating and describing the Cambridge Accumulator Tester is being issued to the electrical trade by **The Cambridge and Paul Instrument Co., Ltd.**, of 45, Grosvenor Place, London, S.W.1. Any reader who has not yet received a copy should make a point of applying for it at once. The instrument appears to be one which should be of value to every man in charge of accumulator plant.

"Facts for Consideration" is the title of a well-printed publication detailing the advantages of electric trucks, as supplied by **The Chloride Electric Storage Co., Ltd.**, of Clifton Junction, Manchester. It is a remarkably well illustrated production and sets forth in clear language the economies which may be effected by using these very useful aids to works efficiency moving. It also contains an excellent series of illustrations showing the form of construction of the Exide Ironclad Battery, and should most certainly be in the possession of every works engineer and manager.

Various Items.

Files and twist drills are, of course, used occasionally by the majority of our readers, so we think they will be interested in a small advertisement of them in our prepaid columns.

Mersey and West Lancashire Electricity District.—The Electricity Commissioners have decided to commence the Inquiry at the Town Hall, Liverpool, at 10.30 a.m. on Thursday, May 17, instead of on May 15, as previously arranged.

Financial.—Congratulations to the Western Electric Distributing Corporation, Ltd., on the very healthy outlook which it is now enjoying. This undertaking controls the electric lighting in eleven town, and it has also applied for Parliamentary powers to increase its area of distribution still further. The consulting engineers are Messrs. Sir Charles Bright and Partners, Ltd., of 146, Bishopsgate, London, E.C.2, to whom much of the credit is due.



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A POPULAR SCIENTIFIC WEEKLY JOURNAL
ELECTRICITY
A PRACTICAL TRADE JOURNAL

MAY 18, 1923.

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THE SALVAGE OF TOWN REFUSE.

Electricity plays an important part in the latest equipment for sorting and grading town refuse, converting its every constituent into a marketable product and rendering valuable what has hitherto been regarded only as filth—a nuisance to the sanitary authorities and a menace to the health of the community. The refuse salvage plant recently installed by the City of Westminster at Lock Wharf, Ebury Bridge, was designed and constructed by the Coppee Company (Great Britain), Ltd., of 14, Grosvenor Place, S.W.1, in association with Captain F. W. Cable, Chief of the Highways Department, Westminster, and it was our privilege to be present when the plant was formally opened on May 3 by the Right Hon. A. Neville Chamberlain, M.P., Minister of Health. After the opening ceremony, in the course of which the Minister of Health and the Mayor of Westminster (Councillor Frank Rye) both pointed out the economic and sanitary advantages of the process, we had an opportunity of inspecting every part of the installation.

The salvage plant is housed in a large building open on the two sides to the road and canal respectively, thus offering ideal facilities for the delivery and removal of materials by road or water as may be more convenient. The refuse as brought in by the collecting lorries (passing over a 20-ton weighbridge) is tipped on to a grillage of bars which arrest any exceptionally large material, such as mattresses or carpets. All the ordinary refuse falls through into a hopper below. The grid and the hopper are within a shed-like enclosure, from which the floating dust is withdrawn by a Duper centrifugal fan (Messrs. David Rowell and Co., Ltd., 14, Howick Place, S.W.1), driven by a 5-h.p. electric motor. The dust is collected in filter bags and forms a concentrated manure of considerable value—by-product No. 1.

Material in the hopper is fed by rotating arms on to the bottom of the belt conveyor, which rises at an angle from the basement at one end of the building to elevated platforms at the other end. The belt is of balata, 2 ft. 6 in. wide, and is supported by rollers mounted on a steel framework; an automatic device for maintaining suitable tension in the belt is located in the lower return run of the latter. Men stationed on duck-boards alongside the belt pick off from the thin layer of refuse any rags, bottles, bones, or other material which cannot be separated automatically, but which is worth collecting for sale. Each picker is deputed to extract only one or two materials, which he deposits in hoppers provided for the purpose at his station.

It will be seen that the refuse reaching the top of the belt run consists mainly of paper, tin cans, cinders, ashes, bricks, stones, etc., and miscellaneous "dirt." At the top of its run the belt passes over a drum-type magnetic separator, this being situated under the hood or nozzle of what is really a gigantic vacuum cleaner. The fierce current of air into this nozzle, induced by a centrifugal fan driven by an 8-h.p. electric motor, carries away all paper and straw, as well as any rags that may have been overlooked by the pickers. This material passes through overhead pipes to a cyclone settler whence it falls into a press and is baled for disposal. The baling press, electrically driven by a 4-h.p. motor, compresses the paper into compact bundles weighing from $2\frac{1}{2}$ to 3 cwt. each (about 47 in. by 17 in. by 22 in. to 24 in.), and it may be noted that this material forms one of the principal products of the salvage both in amount and value.

The magnetic separator holds the "tins" and other magnetic materials on the belt until a special chute is reached (far round the drum), at which point they are released and then fall into a tin-baling press—also electrically driven by a 4-h.p. motor—which makes bales weighing from $1\frac{1}{2}$ to 2 cwt. each and measuring 36 in. by 18 in. by 16 in. Needless to say, this is also a valuable source of income.

"Bijoli" presses (Messrs. Shirtliff Bros., Ltd., Letchworth) are used for both the paper and the tins. They are driven by direct coupled motors with push-button control, automatic brakes to hold the load in any position, and automatic switches to stop the presses at the limits of the travel.

The material, which is neither held by the magnetic separator nor whisked off by the paper collector, is shot straight from the end of the belt into a revolving screen. The latter has two sets of holes which respectively pass material up to about $\frac{3}{8}$ in. and 1 in. diameter; larger material passes into a swing-hammer pulveriser, which is driven by a 50-h.p. motor.

The two sizes of material passing through the rotary screen are carried by water troughs into separate washing tanks. The latter are relatively deep, and the water in them is kept pulsating by air blowers. The lighter or combustible material is carried off by the water overflowing from the tanks into draining hoppers, and forms a suitable fuel for slow combustion stoves, gas producers, etc. The heavier material, such as clinker, glass, stone, pot, etc., sinks to the bottom of the tanks, whence it is removed by elevators, drained, and deposited in overhead bunkers. So far as can be seen, this material can only be used as "filling," but experience may show that it has some more valuable application.

That portion of the refuse which reaches the pulveriser is there reduced to fragments by the action of the hammers revolving at 1,000 r.p.m. within the cast-iron casing. The pulverised product may be used as manure or in other applications according to its com-

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position. Vegetable refuse is, for the most part, collected with the light material which floats off from the washing tanks, and its presence will, we imagine, make it necessary to dispose promptly of the other combustible material with which it is mixed.

Water for the washing plant is drawn from the canal and circulated by a centrifugal pump (Gwynnes Engineering Co., Ltd., Hammersmith), driven by a 14-h.p. motor. Before returning to the canal the water settles in a large tank, the sediment being considerable in amount and valuable as a manure.

The belt, elevators, screen, blowers and certain other parts of the installation are driven by a 25-h.p. motor through suitable shafting, belts, pulleys and gears. It will be seen that the total power of the motors installed in this plant (which is expected to deal with 100 tons of refuse per day) is about 110 h.p. The building is electrically lighted throughout, and readers will be interested to hear that the whole of the electrical equipment was supplied by the General Electric Co., Ltd., of Magnet House, Kingsway, W.C.2.

The lay-out of the whole of this interesting installation bears evidence to the care and foresight displayed in its design. For example, every product of the salvage is delivered in the manner and at the level most convenient for its subsequent removal. We congratulate the City of Westminster upon its enterprise in laying down this plant which, although it is in the nature of an experimental installation, will, we are confident, prove a practical success, by turning waste into wealth and, at the same time, raising the standard of public hygiene.

THE "PARTRIDGE" DUPLEX LIGHTING UNIT.

The "Partridge" Duplex Lighting Unit (illustrated in Figs. 1 and 2) has been designed to enable a more brilliant illumination than that provided by an ordinary floor standard to be obtained when desired. This device is equipped with three or four lamps. One,

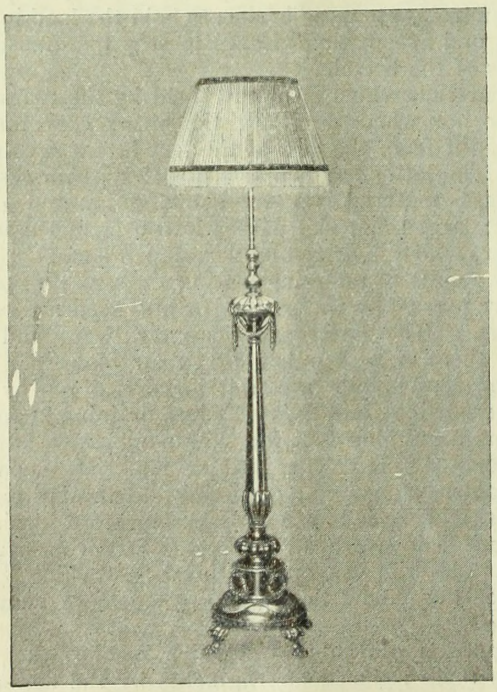


Fig. 1.—Floor Standard Fitted With "Partridge" Duplex Unit.

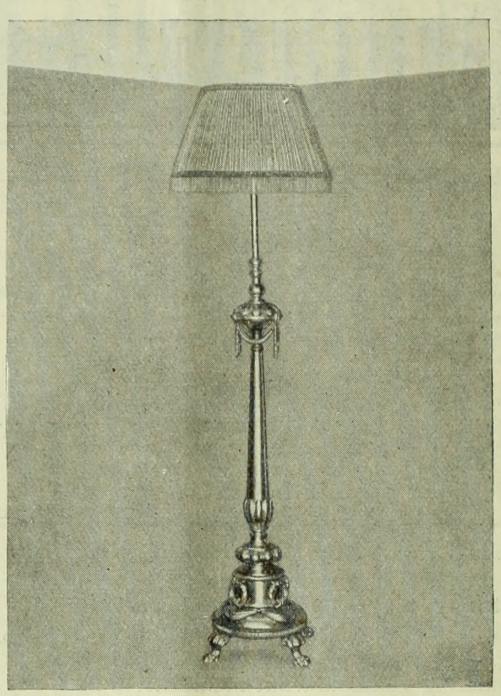


Fig. 2.—Floor Standard Showing Indirect Lighting Effect.

preferably a gasfilled lamp, is arranged within an inverted vitreous enamel conical reflector hidden by the silk shade, and thus provides a good totally indirect illumination over a large area. The other two or three lamps are on the under side of the conical

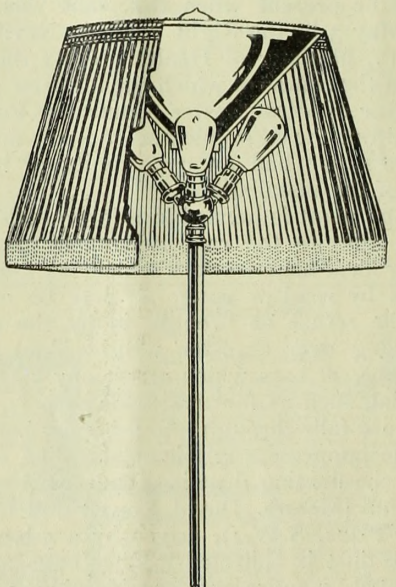


Fig. 3.—Sectional View of "Partridge" Duplex Unit.

shade, and provide the usual local illumination. A two-way switching device is fitted, so that either the indirect or the direct lighting can be employed separately or both together. Fig. 3 shows a sectional

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view of this, and gives a clear indication of the manner in which the various effects are obtained.

Among the important advantages claimed for the Duplex Unit are :—

1. The indirect lighting can be adjusted by means of a telescopic arrangement, so that the rays strike the wall at the level of the picture rail or frieze.

2. All the advantages of perfect diffusion and shadowless illumination associated with indirect lighting are obtainable, while the criticism often levelled against this method of illumination, namely, that the lighting is cold in character, is overcome by means of the direct element of the lighting from the lower lamps.

This combination of indirect and direct illumination has a third advantage, in that the illumination has a fairly substantial horizontal component, which enables pictures and other items of interest on the wall to be well illuminated.

The Duplex Unit, for which provisional protection has been granted, is the invention of Mr. G. W. Partridge, and has been developed by the General Electric Co., Ltd. The photographs from which the illustrations in this article were reproduced were taken in their showrooms at Magnet House, Kingsway, London, W.C.2.

We understand that the company is also considering the adaptation of this unit for pendants as well as for floor standards.

BRITISH EMPIRE EXHIBITION.

It is important that the public should realise that the outstanding feature of the Exhibition will be its educational purpose in relation to science, art, commerce and industry. Scientific instruments, for instance, will form a notable feature of the exhibition. It is hoped to include representative surgical, optical, meteorological and photographic appliances. Great care has been taken that the sports and amusement sections of the exhibition shall not conflict with the sections devoted to more serious objects. The amusements will be confined to the Amusements Park, which will be a separate area of the exhibition; while sports and games will take place either in the Stadium or in the swimming lakes. The latest inventions and the most up-to-date tools of the workshops of science will be brought, by means of this exhibition, to the notice of a wider public, and new opportunities will be created for the development of trade in these industries.

Finance.—The annual report of the Urban E.S. Co., Ltd., for the year 1922 shows a net profit balance of £122,000, and after making ample allowance for debenture interest, reserve, depreciation and preference share interest, there is a balance of £8,000 to be carried forward.

Works Removal.—The works of St. Helens Cable and Rubber Co., Ltd., will in due course be moved from Warrington to Slough, where machinery is being put down at a new factory which has been bought owing to the existing premises at Warrington having proved too small to cope with the steady growth in the company's business. The Slough works consist of a factory already erected, which, with the land adjoining, amounts to about 200,000 square feet, and it is intended that it shall be as nearly as possible in full working order before further machinery is transferred from the old factory. This is with a view to avoid any interference in the execution of orders.

THE "W. E. HIGHFIELD SHIELD" COMPETITION.

A meeting was convened at the St. Bride's Institute, Ludgate Circus, E.C.4, on Tuesday, May 8, under the auspices of the National Association of Supervising Electricians, for the purpose of deciding the winner of the competition for the "W. E. Highfield Shield," particulars of which have already appeared in our columns. Thirteen competition papers were sent in, and each was read over at the meeting by members—not the writer's—and the audience were given voting papers to mark which paper, in their opinion, ranked as first, second and third in order of merit. The president, Mr. W. E. Highfield, in opening the meeting, pointed out that the duty of the gathering was not an easy one, but he hoped that, after hearing the papers in question, a satisfactory result would ensue. No names were mentioned until after the voting had taken place, numbers only were given, and these numbers were drawn from a glass on the chairman's table, and the order in which they were drawn and read was :—

Paper No. 5.—"Use of Cab Tyre Sheathed Conductors for Internal Wiring."
,, No. 6.—"The N.A.S.E." (A criticism.)
,, No. 10.—"The N.A.S.E. and the Electrical Industry."
,, No. 13.—"Trade Unionism."
,, No. 2.—"Distribution of Electrical Energy in a Modern Fighting Ship."
,, No. 12.—"Mutual Help."
,, No. 1.—"Modern Lightning Conductors."
,, No. 11.—"The Future of the Electrical Industry."
,, No. 9.—"Power Factor Improvement."
,, No. 3.—"Electro-Chemistry."
,, No. 4.—"The N.A.S.E. as a Trade Union."
,, No. 7.—"Alternating Current Motors."
,, No. 8 was withdrawn by agreement.

It was, as the chairman had previously remarked, a most difficult task to vote for the first three places out of such a really excellent number of papers. Nos. 7, 3 and 9 were technical matters and most interesting. No. 6 was a "breezy" criticism of the N.A.S.E. No. 7 was instructive, and also interesting. However, the reading of the papers concluded and the voting lists were handed in to the scrutineers, with the result that the winning papers were Nos. 6, 3 and 2, and then the names of the respective authors were announced, viz. :—

Paper No. 6.—Mr. E. E. Gammon (1st prize).
,, No. 3.—Mr. R. W. J. Stark (2nd prize).
,, No. 2.—Mr. J. J. Southern (3rd prize).

The prizes being :—1st, Shield (in oak and silver), presented by W. E. Highfield, Esq., and a "Revo" wireless receiving set presented by the Cable Accessories Co., Ltd.; 2nd, two guineas cash; 3rd, one guinea cash.

The prizes were presented by A. H. Dykes, Esq., M.I.E.E., who said he was proud of the tone of the papers, and congratulated the successful winners (Mr. R. W. J. Stark was unavoidably absent). An acknowledgment from Mr. E. E. Gammon, and a hearty vote of thanks to the chairman terminated a very instructive and enjoyable evening. H. M.

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THE ISSUE OF DETAILS "ON LOAN" FROM THE STORE.

Few matters regarded as a perfectly legitimate proceeding cause as much trouble in the factory as the withdrawing of details from the store "on loan," and their subsequent return. In many engineering factories the receipt of a requisition signed by a foreman and endorsed "on loan" is sufficient for the storeman to issue the details enumerated, but after this transaction is completed it does not appear to be anyone's business to make a further move. The routine ordains that the requisition shall be retained in the store pending the return of the details covered, when it is handed back to the foreman for cancellation. But what happens if the details are not returned?

A requisition for details "on loan" is not as a rule sent to the records clerk for posting the card records, otherwise a credit note would be necessary to put the cards right when the details are returned, and such a procedure (if somewhat frequent) would serve to make the record appear complicated, apart from the cost of the paper forms and the unproductive time involved For the requisition to be held by the storeman and handed back to the foreman when the details are returned is quite a good proceeding, so long as the loaned parts are returned within a reasonable period. The foreman, having had his requirement satisfied, is not disposed to worry himself unduly in the matter of returns, and the initiative must, therefore, be taken by the storekeeper.

Unless this is done, it is more than possible that many of the details never will be returned—the retained requisition is mislaid or accidentally destroyed, and the stock records are incorrect. The whole transaction is speedily forgotten by all the parties concerned, and a further requisition received at a later date for similar details "on loan" is executed without comment, no reference to the previous transaction being made by either party.

The assemblers may require bolts for temporary erections, and these are requisitioned "on loan." No matter how many similar bolts are already in the department, each new requirement means another requisition. The writer has (on many occasions) seen 2 cwt. of bolts collected from one assembling department, the accumulation of stores issues "on loan." Had a proper procedure been observed, such an accumulation would not have been possible, for the second requisition for a supply of, say, 24 $\frac{3}{4}$ in. by 5$\frac{1}{2}$ in. bolts "on loan" would have been turned back by the storekeeper, with the intimation that a supply of such bolts was already in the department. It may be, of course, that further supplies are necessary, the bolts already supplied still being in use, but when this is the case the requisition could be endorsed "additional supplies," which would be the authority for the storeman to issue without comment.

The method adopted in one factory to obviate trouble is as follows. All requisitions for details "on loan" are tabulated, and each week-end the storeman sends to each foreman a list of such parts, together with the dates of issue. The foreman is then expected to collect and return to the store such details as are finished with, and to return the list to the storekeeper with the words "in use" written against the items which cannot be returned at the moment.

But whilst common parts, such as bolts and nuts, etc., may be returned to store and directly accepted into stock for subsequent reissue, machined or assembled details, issued "on loan" for experimental or other purposes, should not be accepted back into stock unless accompanied by an inspector's report certifying that the part has sustained no damage, otherwise trouble may be experienced at a later stage, when a faulty detail is included in a batch issued to the assemblers. The store assistants, therefore, have instructions not to accept details (other than the common stocks already referred to) from any department other than the inspecting room.

The assistant storekeeper actively interests himself in the question of details issued "on loan," and deals personally with those requisitions which have been long outstanding. In this way the privilege of drawing details from the store "on loan" is not abused, the accuracy of the stock records is not adversely affected, and a good deal of trouble and wasted time is thereby eliminated.

Questions and Answers by Practical Men.

RULES.

QUESTIONS: *We invite our readers to send us questions, preferably on technical problems that have arisen in actual practice. Questions which we consider of sufficient interest to our readers will either be replied to under "Answers to Correspondents" or replies will be invited from our readers. One shilling will be paid for the question which we select for competitive replies in this column.*

ANSWERS: *A fee of 10s. will be paid for the answer which we consider shows the greatest merit, and 5s. for the one we select as second best. In judging the replies, importance will be attached to clearness and conciseness, as well as accuracy. The Editor reserves the right to make no award, or to accept only one reply, if, in his opinion, the answers received do not possess sufficient merit. Competitors desiring the return of their manuscripts, if unaccepted, should enclose stamped addressed envelope.*

Write on one side of the paper only, and if diagrams are sent, draw them on a separate sheet of paper attached to the manuscript. Competitors may adopt a "nom de plume," but, both in the case of questions and answers, the competitor's real name and address must be sent with the manuscript as a guarantee of good faith No correspondence will be entered into with regard to successful replies. The Editor's decision is final.

Commencing with Question No. 101, a Diploma of Merit will be awarded to the six competitors who win the first or second prize the most times during the next twelve months.

The words "Questions and Answers" or "Q" and "A" should be placed at the top left-hand corner of all letters intended for this column.

QUESTION No. 159.

I wish to decrease the speed of a direct current motor under my charge. I desire to do this without the insertion of resistances, which I understand are very wasteful. How can I most efficiently do this? The motor is 40 h.p., 220 volts, compound wound.—"INSPECTOR."

QUESTION No. 160.

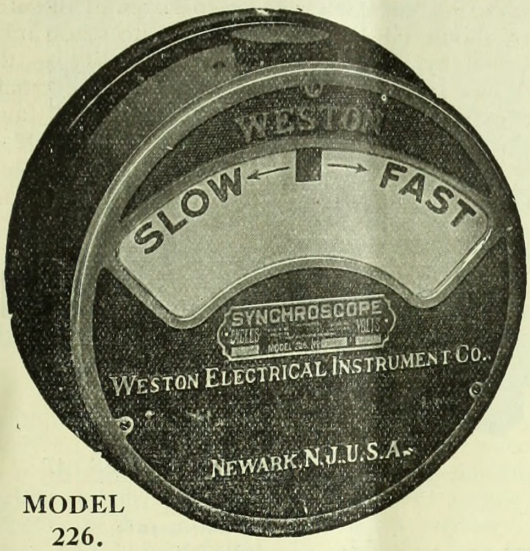
When looking through an old book on cable laying I came across the expression "cable should be taken from the drum and laid in a figure of eight upon the ground before being drawn into the duct." Can any reader tell me why this should be, because the book does not tell me why?—"JOINTER."

(Replies to Questions 159 and 160 must be received not later than May 26, 1923.)

Reconstruction.—The Inventions Development Co., late of Rosemary Street, Belfast, has now been reorganised and a new company, the Inventions Development (1923) Co., formed to carry on the business.

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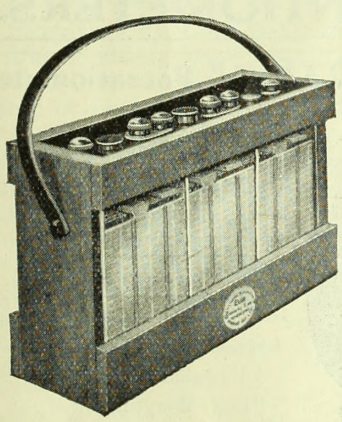
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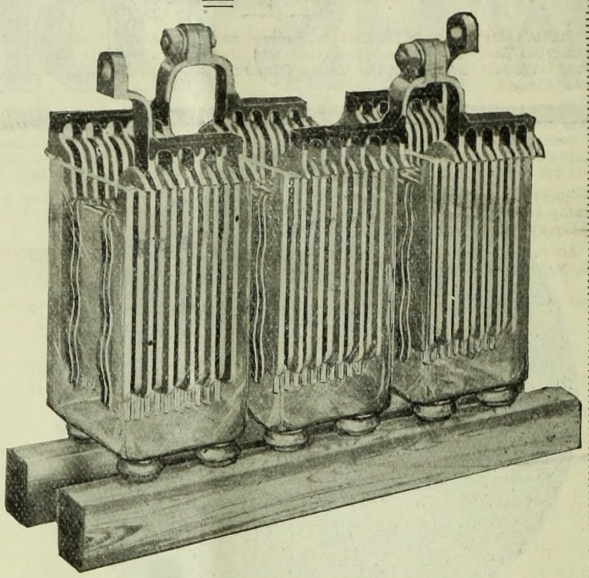
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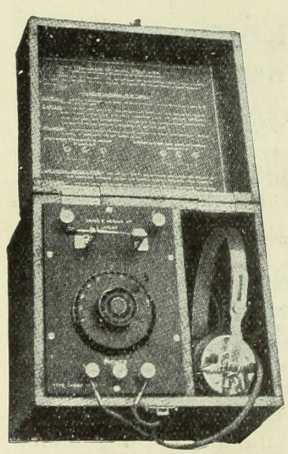
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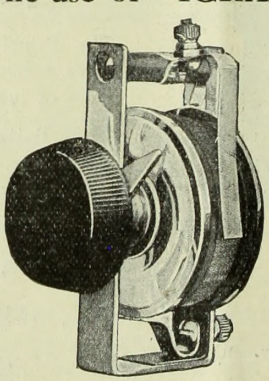
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TO OUR READERS.

ELECTRICITY is published every Friday, and, if ordered, is on sale at the principal Railway Station Bookstalls and Newsagents on that day. It has a very large sale throughout the United Kingdom, as well as in the British Colonies and Abroad.

New advertisements for the displayed columns and alterations to existing ones must reach the publishing office not later than first post Tuesday morning, in order to be in time for the issue of the following Friday. This is important. Rate quoted on application. Subscription: 13s. a year, 6s. 6d. half year, 3s. 3d. a quarter in advance, postage prepaid in the United Kingdom and abroad.

Questions to which an answer is required must be accompanied by a 1½d. stamp for reply. When considered of sufficient interest, the answer will probably appear in the paper.

All remittances payable to the Publishers, S. RENTELL AND CO., LTD., 36-39, Maiden Lane, London, W.C.2. Telephone No. 2460 Gerrard.

Current Topics.

British Empire Patents.

When the unfortunate inventor takes out Letters Patent on a new idea in this or any other country of the British Empire, he is only protected against infringement of his rights in the country of origin, unless he also takes out additional Patents in those countries where he thinks his invention is likely to be profitably developed. In any event, he is in for a costly expenditure on the safeguarding of his rights and privileges, if he desires to secure the full benefits of his invention in British territory both at home and abroad. For this reason it has long been urged that a British Empire Patent should be available for inventors, which would afford them adequate protection of their ideas throughout the British Empire at fees within reach of those inventors who now, through lack of funds, are compelled to limit their protection to the home country.

It is a matter for congratulation, therefore, that a deputation on the subject of a British Empire Patent, from the British Science Guild, has been sympathetically received by the Parliamentary Secretary to the Department of Oversea Trade, Lt.-Col. A. Buckley, D.S.O. The deputation, which was an influential one, was introduced by Lord Askwith, and strongly urged that the necessary steps should be taken as early as possible by the Government to secure effect being given to the provisional scheme for an Empire Patent, drawn up at the British Empire Patent Conference held in London last June. The scheme provides that a Patent issued anywhere within the British Empire shall extend to the United Kingdom, or to any of the self-governing Dominions, or to India, upon registration in the particular territory in which protection is desired. This will be good news to patentees and inventors who are already mulcted in heavy costs for maintaining their rights, especially where those interests are international in character.

Electric Mine Locomotives.

If only on humanitarian grounds one welcomes the generous offer of Mr. Charles Markham, colliery director, of a prize to the value of £1,000, for the best type of electrical storage battery locomotive for service in deep and hot coal mines in place of pit ponies. The conditions under which these little animals work and exist between whiles are anything but natural, and as the motor vehicle has relieved the long-suffering horse of much of its hardest labour on the surface, so it is desirable to introduce mechanical means of haulage wherever possible below ground, and thereby secure for the smaller breed of animal that share of sunshine and fresh air to which they are justly entitled. The conditions to govern the competition are in process of being drawn up by a panel of judges representative of the coal-mining industry, the Institution of Mining Electrical Engineers, and the Mines Department.

It will be open to manufacturers of any nationality, but the vehicles selected for trial will be tested in this country. Storage battery locomotives for mines are, of course, no novelty, and several types are already manufactured in this country, and used in British pits. There would appear to be little or no difficulty in designing a suitable locomotive in so far as the purely mechanical and electric motor equipment are concerned, and it is highly probable that if any serious difficulty is met with in producing a satisfactory solution in the opinion of the responsible judges, it will centre in the battery. Although modern traction batteries, properly maintained are sufficiently reliable for ordinary surface work, as witness the great success of the electric vehicle in the States and elsewhere, the more arduous conditions and extremes of temperature and humidity met with in some coal pits are likely to introduce new and complicated problems to the battery manufacturer. If and when a satisfactory design is forthcoming, I predict that 90 per cent. of the credit will rightly belong to the maker of the battery with which the winning vehicle is equipped, and, to this end, a "life" test should be an essential condition, such test to be conducted under actual working conditions in the pit.

Safe Railway Working.

The recent announcement of a "speeding-up" policy on the London Underground Railways prompts the reflection that these subterranean systems are probably the safest railway systems in the world. One seldom or never hears of an accident on the underground or tube railways, notwithstanding the fact that in their general principles of operation they closely resemble the electrified surface lines. There are several contributory causes to this excellent record, among which a few will be obvious even to the non-technical reader. In the first place each track has a separate tunnel, and there are comparatively few points where trains come within speaking distance of each other when travelling in opposite directions. Hence collisions are practically impossible, and the only possible contretemps of this kind would arise in the event of one train overtaking or running into a stationary train on the same track as itself.

This eventuality is effectually guarded against by automatic signalling and train stop mechanism, which eliminates the fallible human element and cuts off the current from a following train in the event of any mishap, in addition to applying the brakes. Another frequent source of danger on surface railways is equally safeguarded in the case of the tubes, where it would indeed prove a serious menace, viz., an outbreak of fire. Both locomotives and coaches of the London Underground systems are to all practical intents and purposes fireproof in every detail; it would be impossible to start a serious conflagration, and such minor mishaps as have occurred in the history of the undertakings have been due in the main to burning insula-

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tion on short-circuited or overloaded cables, and have been rapidly and safely got under control.

There is, however, one underlying reason, and a very important one, why the tube railways are practically immune from accident due to failures of the signalling system, a common cause of railway accidents on the surface. It is our old and much discussed friend —the weather. Few people, except experienced railway men, realise what a vital part our erratic climate plays in the safe conduct of British railway services. Hail, rain, fog, frost, sunshine, lightning, all have their different influences on the highly complex signalling gear of a railway system, and a system which is practically infallible one minute may be thrown into hopeless confusion within the space of a quarter of an hour by a sudden shower, or an unexpected fog. Most modern signalling systems depend largely upon electrical principles, and when you come to apply those principles to such exposed and variable elements as miles of railway track, insulated only by wooden sleepers, and depending upon more or less exposed copper bonding at the rail joints for the maintenance of continuity, it is not difficult to imagine a set of conditions, caused directly by weather changes, which will throw the system temporarily out of gear, and introduce an element of danger.

When such things happen, the human element steps in and functions according to rule until the automatic principles are restored to normal. If all the very excellent rules laid down for the operation of railway signals were carefully and meticulously observed, accidents would never happen, and, incidentally, few trains would reach their destinations on time. Rules are made to be, and with the best of intentions occasionally are, broken in railway practice, with serious, or even fatal results. The London Underground railways are fortunately immune from all weather troubles. They operate under ideal conditions, in a dry oxygenated atmosphere, where climatic vagaries cannot touch them. To this last factor they doubtless owe their practical freedom from serious accident.

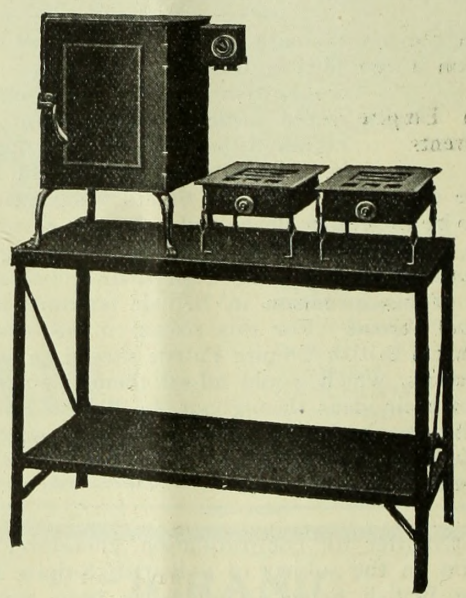
Scholarships.

I trust that all the readers of this paper who are in any way eligible will do their best to enter for the scholarships in electrical engineering which are being granted so generously by the Council of the B.E.A.M.A., and of which particulars are given in another column of this issue. It is, indeed, a pleasure to see that budding engineers of British birth are being assisted in their endeavours to make good in our great profession, and I trust this example will be imitated in other directions. At any rate, it should also act as a direct incentive to manufacturers who are not in the Association to join it without delay, because the greater the membership the more money can be spent in technical education, and the more likely we are as a nation to make up the leeway at present existing owing to restrictive legislation in the early days of the industry in this country. I shall most certainly look forward with much pleasure to the date when we can announce in these columns the names of the ten candidates who are successful in the next list of entrants. Good luck to them is the cordial wish of

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A NEW DOMESTIC COOKER.

A strong, serviceable, conveniently arranged electric cooker at a popular price has recently been designed and put on the market by the Arora Co., of Loughborough. The complete kitchen outfit is illustrated. It comprises an oven 16 in. by 12½ in. by 12 in., inside measurements, on 6 in. legs, two boiling plates, and a sheet metal table. An alternative arrangement is to have the oven mounted on 15 in. feet, and one or two boiling plates mounted on the top, though, unless space considerations come in, the former method has many advantages which are obvious to all who have to use



cooking apparatus. The oven has double walls of sheet iron, air lagged, with bright black finish. The controls give 1,800 watts (top and bottom elements), 750 watts (bottom element only), 450 watts (top and bottom elements in series). A temperature of 400/450° F. is obtained with both elements on in 15 to 20 mins., when cooking temperature may be maintained with both elements in series for one hour.

The boiling and simmering plates have two elements, one rated at 1,000 watts for boiling, and another, which is put in series with the first for simmering purposes. In this case the consumption is about 200 watts.

Further particulars of this equipment and of the Arora Rapid Grill and Bungalow Cooker are available in a new leaflet, which may be had from the manufacturers, in whose list "A" is also to be found their full range of Arora electric fires.

Holidays.—Messrs. Higgs Bros., of Sand Pits, Birmingham, state that their works and offices will be closed from Friday evening, the 18th inst., to Wednesday morning, the 23rd inst.

Bargains in Lathes.—Messrs. Holmes, the well-known machine-tool makers, of Bradford, are offering special bargains in lathes which should appeal to all manufacturers of electrical apparatus. They have an advertisement on another page.

N.E. Midlands.—The Electricity Commissioners have considered the evidence given at the inquiry held by them last November and December, and have come to certain decisions with regard to the area of the proposed electricity district and the constitution and establishment of a joint electricity authority for the district. These decisions will be embodied in a draft order which will be issued shortly.

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THE MAINTENANCE OF VOLTAGE ON A D.C. DISTRIBUTION SYSTEM BY MEANS OF A FULLY AUTOMATIC SUB-STATION.*

BY P. J. ROBINSON.

(*Continued from page 242*).

A protective relay (38) is provided with its coil in series with the shunt field of the converter. This relay ensures that the field strength of the converter is adequate before any load can be taken. When the field strength has reached its normal value, a circuit is established through a contact on relay (3) through an interlock on the brush-lifting device (31), through the contacts of field relay (38), and through the operating coil of the auxiliary shunt relay (37a). Relay (37a) in turn closes the main contactor (37), which is in the d.c. converter circuit. Although the contacts of (37) are in the d.c. circuit, its operating energy is obtained from the a.c. circuit.

Another contact of relay (37a) completes the d.c. closing-coil circuit of the main d.c. operated contactors (12). This circuit, when closed, connects both poles of the converter to the busbars through limiting resistances. The d.c. accelerating relays, (12a) and (12b), measure the amount of load picked up and, if this is not excessive, allow contactor (16) to cut out the limiting resistances.

Should the converter during its operation become greatly overloaded, these accelerating relays will work in the inverse order and insert the limiting resistance to limit the load. If this load should persist, grid thermostats (28) will shut down the automatic equipment, when the resistance grids reach approximately red heat. These thermostats will allow the station to start up again when the grids have cooled down.

The overload setting of the d.c. accelerating relays is purposely made very high to permit the full overload capacity of the converter to be utilised for short overloads. If the overloads should be of such magnitude as not to operate the accelerating relays, and should they persist long enough to endanger the windings of the converter, a thermal time-element relay (29) will shut down the converter and allow it to cool off. After such cooling the converter will again be put into service automatically. This thermal relay measures the R.M.S. value of the a.c. input to the machine. This is an accurate measure of the heating in the machine.

A d.c. reverse-current relay (32) is provided so that, if the a.c. supply should become inadequate while the machine is connected to the d.c. system, the converter will be disconnected from the line before the reverse flow of energy can damage it.

Induction overload relays (23) are provided which protect against short-circuits in the converter or converter leads. They also operate in case of a serious flash-over.

Thermostats are provided in each of the machine bearings, and, should any of these operate, a lock-out relay (30) is closed, thus taking the converter entirely out of service by short-circuiting the operating coil of relay (3a). This lock-out relay (30), whenever operated, must be reset by hand. An auxiliary contact is provided in the relay so that a signal circuit may be energised if desired. This signal circuit may operate semaphore or lights in front of the station, or send signals over a telephone or telegraph circuit to give warning of the trouble.

Relay (46) is an induction-type relay but of special construction so as to constitute an unbalanced phase-current relay. The relay coils are connected to the three current transformers in the low-tension circuits. During the starting operation the contacts of this relay are put in series with the operating coil of the lock-out relay (30) by an interlock on the starting contactor (6), and should any fault occur during the starting period the lock-out relay (30) is at once energised, thus closing down the entire automatic equipment. Normally, however, the trip contacts of relay (46) are connected across the operating coil of relay (3a) by an interlock on starting contactor (6), which closes when the contactor opens. Thus, should any trouble arise on the high-tension line while the converter is running, it will be shut down by master relay (3a), but will be left in condition to restart automatically as soon as the high-tension line is again in a satisfactory operating condition.

Each of the feeders is provided with magnet contactors, (40) and (41), which open in the event of an overload by the action of overload relays (51) and (52). When these overload relays open they are held in the open position by a mechanical latch and cannot be closed until the respective re-setting coil, (51) or (52), has been energised and has thus released the latch. While in the open position the contactors are shunted by a measuring resistance bridge, the circuit to the mid-wire of the feeder being completed by a contact on (47) or (48) which closes when the relay (47) or (48) is de-energised. This occurs as soon as the feeder contactor (40) or (41) opens, since the operating coil of the relays is short-circuited by an auxiliary contact on the contactors which closes when the contact is open. The resistance bridge is now used to measure the resistance of the feeder. As the load on the feeder is reduced, the voltage-drop across the relay-shunting resistance increases until at a pre-determined value the contacts of relay (34) or (35) close, thus completing the circuit of the re-setting coil (51) or (52). When the re-setting coil has operated, the closing-coil circuit of the contactor (40) or (41) is again energised and closes the contactor, thus restoring the feeder to service. The resistance bridge is disconnected from the neutral after a small time-interval by the operation of relay (47) or (48), which is energised through the opening of the auxiliary contact on the feed contactors. The above arrangement is such that an overload on either of the outers will cause the respective feeder to be disconnected, and only reconnected when the overload has been reduced.

When the demand for power falls to a predetermined value under load, d.c. relays (13) operate to close their contacts and thus energise an underload delay relay (27). After an interval of time, which can be adjusted to be from 3 to 20 minutes, the time-delay relay closes its contact and short-circuits the coil of relay (3a), which opens and de-energises relay (3). When relay (3) opens, it de-energises all the a.c. operated contactors and also causes the main oil circuit-breaker (20) to open. The station is now ready to start up again when the demand for power causes the d.c. voltage to drop.

The sequence of operations described above is very quickly performed, the total time from the demand arising to the connection of the rotary converter to

* Paper read before the I.E.E.

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the line being seldom greater than 55 seconds, plus the time-lag on the relay. This is a great advance over manual operation, which necessitates synchronising by hand.

The operation of the station has surpassed our expectations in that its behaviour has been almost perfect since it was first put on load, or, rather, put itself on load.

Naturally, numerous adjustments to the relays, etc., have been necessary, but this has been to enable them to meet our conditions of working.

At this point it might be as well to consider in detail the control of the outgoing d.c. feeders, and to consider two possible requirements, i.e., to control a dead-ended feeder and an interconnector fed from another source of supply. With this end in view the re-closing mechanism was designed to be applicable to both.

The feeders are therefore protected with automatic re-closing contractors having overload and inverse time-limit relays. Auxiliary contacts on these contactors are arranged to connect measuring resistances across the feeder circuit when the contactor opens. In the case of a dead-ended feeder they measure the resistance of the system, and if this is above a pre-determined value the contactor closes again. If it is not of the requisite value the contactor is prevented from closing; if at a later period the fault is removed, the contactors close and restore the supply.

In the case of an interconnector fed from another source of supply the contactors close only when the voltage of the interconnector has risen to a pre-determined value. The operating relay is adjustable over a wide range, and any reasonable conditions can be met with the apparatus as installed.

Various artificial faults have been put on the plant for experimental purposes, but have all been dealt with almost uncannily.

The relays are of substantial construction, and we do not anticipate that they will give us any trouble provided that they have reasonable attention.

The fact that we have put a second station in hand on similar lines to the one described rather points to our entire satisfaction. The author would point out that, in the station described, arrangements were made to run the plant for traction purposes when desired, the automatic features functioning up to and including the rotary-converter d.c. contactors, following which is a hand-operated throw-over switch, which may be closed on either the lighting or traction busbars as desired.

The traction feeders are controlled by hand-operated standard circuit-breakers and knife switches. As this station is on a tramway route which several times a year has to handle very heavy traffic, this arrangement is very useful, especially as the station is situated on the top of an incline.

It is of interest to refer to the problem with which we had to deal, and the cost comparison which influenced our decision.

The network between the two stations mentioned was laid at a pre-war cost of approximately £20,858, but as only 40 per cent. was available for useful work, due to voltage-drop, a feed into the centre would enhance its value nearly three times. The following five methods were open to us:—

(1) To change over the whole of the distribution in the area in question to alternating current, by connecting the d.c. mains across a split single-phase transformer. This would mean that only a single-phase supply would be available, and that all consumers' d.c. plant, such as motors, etc., would have had to be replaced by a.c. plant.

(2) To replace the whole of the d.c. mains by a.c. mains, creating a new a.c. system and finally scrapping the d.c. mains; or else to superimpose on the area an a.c. supply. This would mean that there would be two systems in the same area, that the d.c. consumer would be restricted to his existing load, and that the capacity of the d.c. mains would remain at their present value, i.e., only 40 per cent.

The cost of the above methods, coupled with their obvious disadvantages, led to their elimination, and only the three following schemes were considered in detail:—

(3) To lay new d.c. feeders from the existing stations to a central point of the system, the feeders to be of sufficient capacity to increase considerably the value of the system.

This scheme would meet the present difficulty, but did not allow for further extension or of new distributors being laid down from the point where the feeders fed into the system.

(4) To erect a new building and equip it with manually operated plant with three double shifts of operators.

(5) To erect a new building and equip it with fully automatic plant requiring the occasional services of an inspector.

Alternatives (4) and (5) would allow for very considerable extension to the existing distribution system, as new distributors could be installed as and when required.

Whichever of the three schemes was decided upon, new buildings and plant would be required, as the present feeding stations were not large enough to allow of more plant being installed, and the existing plant was fully loaded. Therefore, in considering the comparative cost of the schemes, the cost of buildings, rotary converter, manually-operated converter and feeder gear has been taken as being common to all.

Considering first the capital cost of alternatives (3), (4) and (5) and ignoring the items common to each, the following would appear to be a fair basis of comparison:—

(3) The cost chargeable is the value of the new cables required from Cobbs Quarry and Rice Lane, together with the cost of laying the same to feed into the network at the position chosen, namely, £12,500.

(4) Over and above the cost of laying a short length of feeder out of the station to connect up, the cost would be nil.

(5) The cost of the automatic gear, over and above the cost of manually operated gear, £1,795, and connecting up feeders as in (4).

No sum has been added in cases (4) and (5) for connecting up the feeders, as the cost would be very little and the annual charge less.

(To be continued.)

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A.C. NEUTRAL POINT EARTHING.

BY S. AUSTEN STIGANT, A.M.I.E.E., M.AM.I.E.E., MEMBER J.INST.E.*

This short review of the theory and practice concerning the neutral point earthing of the H.T. and L.T. three-phase systems is written chiefly with the view of placing before those not so familiar with the problems involved the advantages of neutral point earthing and the steps taken for earthing under different conditions. The disadvantages of operating with an insulated neutral are also briefly outlined.

As electric power is now mainly transmitted and distributed by the three-phase system, the subject matter of this paper has been confined accordingly.

The insulated neutral point.—In the earlier days of electrical power transmission and distribution it was the usual practice to operate three-phase systems with the neutral points insulated, as such systems were relatively small and earth faults did not produce particularly disastrous results. In addition to this, transmission and distribution pressures were not so high as they now are, and again the results of an earth fault were not so far-reaching.

On a system operating with an insulated neutral the fault most to be feared is a breakdown to earth on one phase, particularly if this takes the form of an arcing ground at an overhead line insulator. From such a fault pressure waves proceed along the line in both directions, and it is no uncommon occurrence for secondary breakdowns to take place simultaneously at points on the system widely apart.

Generally speaking the danger is most acute when the fault to earth occurs at an overhead line insulator, but on the other hand there still remains reason for apprehension when the system consists purely of underground cable, though an earth fault in a three-core cable is generally quickly converted into a short circuit between phases, and the cable then becomes isolated from the supply.

Should a sustained earth occur on one line the pressure of the faulty line drops to some value between the normal phase pressure and zero depending upon the resistance of the fault. The pressure of the other two lines increases, and the system becomes electrostatically unbalanced. The dielectric stress on the two sound phases becomes increased according to the increased pressure on these phases, and the insulation of all apparatus connected to the system is correspondingly overstrained. On very high voltage systems where transmission is carried out by bare overhead conductors, the increased pressure on the two sound lines may result in the production of corona, which represents a definite power loss and also results in the introduction of harmonic phenomena. The charging current also increases and telephone interference may result.

It has been submitted from time to time that the great advantage of operating with an insulated neutral is that should an earth fault occur on one of the lines the supply need not immediately be interrupted, but that it can be continued until the fault has been located, and a suitable opportunity arises to permit the repair. In actual modern practice this reasoning is entirely fallacious, for often it is exceedingly difficult to locate a pure earth fault, particularly if it is of high resistance, and as therefore the process of location may be a lengthy procedure, the insulation of apparatus connected to the system is being overstrained during that time. The fault will more than likely be an unstable one, so that disturbing waves will periodically be propagated along the system, so increasing the risk of breakdown.

It can be said without any fear of contradiction whatever that the practice of operating with an insulated neutral has been responsible for numerous breakdowns of cables, generators and transformers, and such practice is definitely not to be recommended.

The full advantages of the various types of automatic protective gears now in common use cannot be obtained unless the neutral point of the system is definitely earthed, as with the neutral insulated the fault current flowing is only the capacity current of the system under the particular fault conditions occurring (which may or may not trip the relays), whereas with the neutral point earthed the fault current is the short circuit current of the phase concerned, which, of course, may be limited in value to any desired amount up to the maximum phase short circuit current by the insertion of an earthing resistance or similar device.

(*To be continued.*)

* Paper read before the Junior Institution of Engineers.

Trade Notes.

The telephone numbers of the **Chloride Electrical Storage Co., Ltd.**, at their Shaftesbury Avenue Showrooms Depot, have been changed to Regent No. 8070 and 8071, and two more lines—Regent No. 8072 and 8073—have been added.

The "Sunco" monthly stock list for May refers to the fact that the new fittings catalogue of the **Sun Electrical Co.**, of 118, Charing Cross Road, London, W.C. 2, is now ready. It has already been noticed in these columns. The stock list quotes prices of a wide range of accessories, including desk and table fans, for which the recent spell of warm weather should create a steady demand, and we recommend contractors and trade readers generally to write officially and ask for it.

The one complaint about stainless-steel cutlery is that users cannot make it retain a lasting edge. This trouble should not arise if the blades are properly hardened, and to do this it is essential that the heating should be even throughout. For this purpose **Automatic and Electric Furnaces, Ltd.**, of 175, Farringdon Road, London, E.C. 1, have designed a special electric furnace which meets such requirements exactly, and full details thereof are given in an illustrated 4-pp. leaflet, which will be of direct interest to all manufacturers of cutlery and edge tools. Sheffield readers will no doubt be glad to hear of this, and we hope that large numbers of furnaces will be installed.

Messrs. T. W. Broadbent, Ltd., electrical manufacturers, of Victoria Electrical Works, East Parade, Huddersfield, have removed their London office to 17, Queen Victoria St., E.C. 4, to which address all correspondence relating to their London and export trade should now be addressed.

Full particulars of the Igranic potentiometers are given in leaflet Z 49, which has just been issued by the **Igranic Electric Co., Ltd.**, of 147, Queen Victoria Street, London, E.C. 4. The use of these instruments is an aid to the highest detector value efficiency, as well as to the ease of tuning-in any distant station, and they will, we are certain, be appreciated by a large number of wireless users. Contractors and retail dealers in wireless supplies should make a point of obtaining the list without delay.

A useful set of circulars has just been issued by **Engineering Supplies, Ltd.**, of 155a, Upper Thames Street, London, E.C. 4. They deal respectively with enamel and silk-covered H.C. copper wires, cotton-covered wires, wireless receiving sets, conduits and fittings, batteries, bell pushes, shades and wireless component parts generally. They will therefore be of direct value to all trade readers.

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Reviews of Books, &c.

[Books noticed in this column will be sent from Electricity *Office to any part of the world, for the published price, plus ten per cent. for postage (minimum 2d.) and orders will be appreciated.]*

The Empire Municipal Directory and Year Book, 1923-24. 348 pp. and Diary. (Municipal Engineering. 10s. 6d. net. 11s. post free.)—This Directory and Year Book—now in the forty-first year of its publication—is unquestionably the most exhaustive directory of British and Colonial corporations, and county, urban and rural district councils; and it is at the same time an encyclopædia of municipal, highway engineering and public health work. The directory includes a complete list of chief officials, together with their business addresses and telephone numbers, and also constitutes an excellent trade directory of all the principal firms concerned in municipal work. The reader who desires information concerning professional or other institutions associated in any way with municipal activities, can turn to this year book in the full confidence that he will obtain complete and up-to-date information. The work includes a large number of articles, each written by a specialist, dealing with such subjects as road construction and maintenance, building, public lighting, public cleansing, water supply, sewerage, public health, fire prevention, motor transport, and so on. New features in the present edition are the lists of universities and colleges granting degrees in public health and engineering, and articles on labour-saving appliances, and the principal methods of constructing hard tennis courts. By serving also as a diary the book commends itself as an indispensable desk companion of all concerned in municipal work—whether as officials or as manufacturers or contractors.

The Electrician Tables of Electricity Undertakings for 1923. 138 pp. (Benn Bros. 10s. 9d., post free.)—We have pleasure in directing the attention of our readers to the thirty-sixth edition of this well-known annual, which has again been completely revised and considerably extended by the addition of particulars relating to many new undertakings. The list of supply stations in the British Empire is now a comprehensive one. Particulars of some new foreign concerns have also been included, and there is a complete record of supply voltages in Chili, which is, of course, an important field of development for British electrical manufacturers. We need hardly remind our readers that the particulars concerning the various undertakings are now set out in such manner that a maximum of information can be presented, and additions can be made as circumstances warrant. Particulars are given concerning the supply systems, generating and converting plant employed, mains, motor hiring schemes, fuel used, showrooms, prices of electricity, gas, etc. Under present conditions there is, of course, some difficulty in obtaining and verifying data relating to foreign undertakings, but this difficulty is one which should steadily diminish, and, in the meantime, these tables are undoubtedly the most complete in this country, and they are of the greatest possible value to engineers, manufacturers, suppliers and exporters.

Wireless Telephones and How They Work (Third Edition, revised and enlarged.) By James Erskine-Murray, D.Sc. (Crosby Lockwood, London, 4s. 6d. net.)—This small book is almost too well known to require criticism. It is a simple and concise description of its subject by an acknowledged authority. To the uninitiated, the description of how we hear will be appreciated, and the merest tyro cannot fail to follow step by step the author's leading. As a pioneer of his subject, the author writes as an authority on the historical side. The chief function of the book is to describe how the wireless telephone works. One of the author's reminiscences brings home the fact that the land-line telephone itself is only more or less new. In describing his inspection of Lord Kelvin's first telephone instruments, he remarks on the enormous growth that has taken place in the telephone service in the last thiry years, and the remark "Guinea pigs aren't in it" is an illustration of the subtle vein of humour which, although apparently repressed, breaks out occasionally throughout the various pages. Another remark such as this which, unfortunately, from the instrument point of view is only too true, is the following:—"Many electrical instruments work better when you hit them, but this does *not* apply to valves." Another point which we endorse is that referring to the crystal as a rectifier, and particularly the bad spots on the crystal:—"The latter are more easily found." It is always of interest in new books or editions on wireless matters to follow the various analogies used to describe the fundamental facts of wireless. Here we have the steady forward movement of a violin bow producing the to-and-fro movement of a string, the forward movement of the wheelwork of a watch causing the balance wheel to oscillate or vibrate backwards and forwards. Very often a new analogy puts to the reader's mind an entirely different view of the fundamental facts, and in a book of this type one small paragraph may repay the reader. To cite an instance of this, the writer was particularly struck with one of the opening paragraphs of the book, in which sound waves were described as "a rhythmical series of changes of pressure, which spreads in ever-widening spheres throughout the atmosphere." It is the word "spheres" to which I refer. One is accustomed to the use of the words "widening circles." The word "spheres" will no doubt be new to many, and yet it is, of course, the true and correct description, at any rate of sound waves, and to a certain extent, as far as we know, to the electro-magnetic waves. Anyone who reads the book will be amply repaid.

Costing Organisation for Engineers. By E. W. Workman, B.Sc. (Pitman, 3s. 6d. net.)—In a foreword contained in this publication, the importance of accurate knowledge of costs in engineering manufacture is emphasised, and the study of the fundamental principles such as are dealt with in the book are recommended to every young man engaged in engineering manufacture, and while we most heartily endorse this remark, we cannot help feeling that the book will only be of real use to comparatively few, although of interest to many. The organisation described is typical of an engineering firm employing from five thousand to ten thousand hands, and for a firm of this size the methods may be eminently satisfactory. The majority of engineering firms employ from one hundred to six or

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seven hundred hands, and in an average firm such as this a simpler system could advantageously be adopted. In fact, we feel sure that the editor of the book himself would suggest a much more simple system. One of the difficulties in engineering manufacture to-day is due to high establishment charges, owing to the development of war-time organisation as applied to peace-time programmes, and in a very large number of instances the reduction of expenses due to cutting out elaborate systems has shown an immediate improvement. It should be understood that in making these remarks we do not wish to make any statement which would detract from the value of the book, but only to endeavour to show that its scope is a limited one. That the system described is workable on the large scale referred to necessitates nothing else being said in its favour. In addition to the above remarks, it should be pointed out that the system as described is applied only to more or less heavy plant and machinery, such as turbines, motors, generators, transformers, etc.

SCHOLARSHIPS IN ELECTRICAL ENGINEERING.

The British Electrical and Allied Manufacturers' Association direct attention to the fact that, in furtherance of technical education, they grant annually, to properly qualified candidates of British birth engaged in engineering works, ten scholarships, each of the value of £100, in addition to the payment of college fees. The last date for receipt of applications is June 1. Form and full particulars may be obtained by writing to the Secretary, The B.E.A.M.A., 36, Kingsway, London, W.C.2.

Various Items.

Bennett College, Sheffield.—We have received from this well-known educational institution a circular containing numerous testimonials and expressions of appreciation from students who have gained their training and expert knowledge through Mr. Bennett, and we have perused them with interest. We can cordially recommend the institution to the notice of our readers, and we are certain that any of them who may be anxious to take up any special course of study will be able to obtain full and accurate instructions through the medium thereof.

Financial.—The annual report of the Great Northern Telegraph Co. of Denmark for the year 1922 shows a considerable reduction in the traffic receipts, but the directors propose the distribution of a total dividend and bonus of 22 per cent., as before, and to carry forward practically the same amount as was brought in the previous year.——Congratulations to Messrs. Johnson and Phillips, Ltd., who show a profit of nearly £83,000 for the year 1922. A dividend of 5 per cent. on the ordinary shares is being paid, and £18,000 carried forward.

British Industries Fair, 1923.—The Dept. of Overseas Trade, 35, Old Queen Street, London, S.W. 1, announce that copies of the catalogue of the above fair, which was held at the White City from February 19 to March 12, may be obtained, price 1s. post free, on application to the Department. It includes a list of the manufacturers who exhibited, as well as comprehensive particulars of the various goods made by them, and should therefore be very useful as a book of reference to firms requiring information as to where to place orders or make inquiries.

G.E.C. Electrical Enterprise in China.—In order to stimulate interest in China in matters electrical, the Hankow branch of the General Electric Co., Ltd., have fitted up a Chinese house-boat as a travelling showroom, and are sending this on a long trip up the Han River. It is fitted with a G.E.C. country house lighting set, consisting of oil engine, dynamo and switchboard, and the boat will make a stop at every Chinese town passed during the journey, and demonstrations will be given. A plenteous supply of advertisements and pamphlets, printed in Chinese, are being taken on the journey, and one of the well-known Osram poster signs, with additional Chinese characters, is suspended from the mast. It will be interesting to note what success attends this attempt to bring electricity and enlightenment to the up-country people in China.

Pootung.—At present about 7,000 lamps are being used by the Pootung Electric Co. in Pootung, Shanghai, but it is expected that it will soon supply current for 13,000 lamps. Let us hope that they are all of British make.

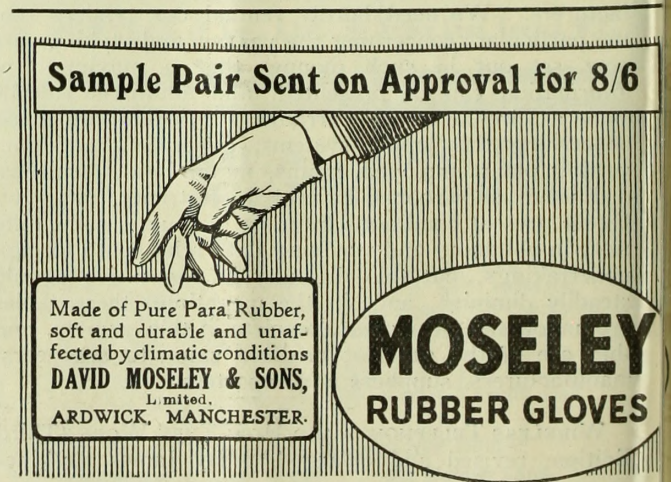
Harbin.—At the Government wireless station plans are being prepared for the installation of a wireless telephone service to attract private subscribers. Wireless telegraph stations are also in successful operation at Mukden, Changchun and Tsitsihar.

Switzerland.—A report on the economic and financial conditions in Switzerland down to December, 1922, has just been issued by the Dept. of Overseas Trade, and can be obtained from H.M. Stationery Office, Kingsway, or from the office of this paper, price 2s. 9d. post free. It contains information on the subject of machinery exports and imports which should prove interesting to electrical engineers generally. The characteristic fact which is set forth most clearly is the definite decrease in the number of new orders which have been received in Switzerland during the past year, which they say has been one of the worst ever experienced.

Norway.—The Report on the Industrial and Economic Conditions of Norway, which has just been published by H.M. Stationery Office (2s. 9d. post free), on behalf of the Dept. of Overseas Trade, contains certain chapters which will interest British manufacturers and exporters who seek to increase their trade with the land of the midnight sun. Communistic labour troubles are in evidence just like they are over here, and wages will have to come down if the country is to return to a sound, prosperous condition. Meantime it is to be hoped that Norway will be able to increase her purchases of British goods, provided always that care is exercised not to buy too heavily.

Railway Electrification.—The Westinghouse Electric and Mfg. Co., of Pittsburgh, U.S.A., announce that they have just entered into a contract with the Virginian Railway Co. for the complete electrification of the line between Mullens and Roanoke (in the State of Virginia), comprising 134 route miles and 215 miles of track. This line will handle a very heavy coal traffic with 6,000-ton trains up about a 2 per cent. grade and 9,000-ton trains over the rest of the line. The contract includes the supply of 600-ton split-phase 25-cycle 11,000-volt locomotives of the most powerful type ever contemplated. The total contract, including a 50,000-kw. power-house, amounts to $15,000,000, and is the largest railway electrification in the world to date.

Personal.—Mr. H. A. Pryor, who has been on the staff of Messrs. Siemens and their associated companies for the past fifteen years, has been appointed manager of the Manchester branch of Siemens and English Electric Lamp Co., Ltd., who also act as selling agents for Messrs. Siemens Brothers and Co., Ltd. We know that Mr. Pryor has a very wide circle of friends, and we are sure they will all join us in hearty congratulations on his appointment, which, as he is a Manchester man, is really a return to his native city. He is sure to do well for his company, although he will be sadly missed by us all in London. Mr. Wm. Kirkham, the late branch manager, on relinquishing his appointment with the company, was presented by his colleagues with an illuminated testimonial and silver tea and coffee service as a token of their esteem.



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MAY 25, 1923.

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THE MAINTENANCE OF VOLTAGE ON A D.C. DISTRIBUTION SYSTEM BY MEANS OF A FULLY AUTOMATIC SUB-STATION.*

By P. J. Robinson.

(*Concluded from page* 260.)

The cost of the high-tension cable in cases (4) and (5) was not taken into account, because in the particular case under consideration the high-tension cable was already in existence and passed the site chosen. In other cases this cost will, of course, have to be taken into account.

As regards the operation of the three schemes:—

(3) Would require very little more attention than at present, as the stations were already staffed and inspection would be as hitherto; also, the lighting would be only slightly in excess of the existing lighting. The cable losses were neglected; plant losses in converters, being common to all three schemes, were also neglected, so that the only charges on this scheme are the capital charges.

(4) Would require three shifts of two men per shift, at £1,285 per annum. As this station would come within the routine of a general inspection, the cost of inspection was ignored. The lighting of the station would cost about £20 per annum, so that the total running charges would be £1,305 per annum.

(5) Would require more skilled inspection and a consequently higher rate of pay than the manually-operated station, but this would be more than balanced by the reduction in clerical work at headquarters, consequent on there being no weekly wages to be made out and paid to shift men.

The station lighting would be nil, as obviously it would not be required.

* Paper read before the I.E.E.

The maintenance in the case of all three alternatives has been considered as common to each, although the maintenance on scheme (5) might be slightly in excess of that on either scheme (3) or (4).

As pointed out above, three shifts would be required in the manually-operated station (4), although possibly only working 50 per cent. of its time, and on this basis station (5), operating on load for 12 hours and being idle for 12 hours per day, with units at 1d. for operation purposes, would cost £93 per annum for energy.

Therefore, in this station we should have a capital charge on the excess of automatic over non-automatic gear, and also a running or operating charge of £93 per annum. This brings us to the following actual charges:—

(3) £12,500 at, say, 9 per cent.... £1,125 per annum.
(4) Running charges ... ... £1,305 ,, ,,
(5) £1,795 at, say, 9%=£162 } £255 ,, ,,
Running charge= £93 }

It would appear from the above figures that, taking the difference between (3) and (5), there would be a saving of £870 in favour of (5) and a difference between (4) and (5) of £1,050 per annum in favour of (5), which represents a considerable saving in the cost of units supplied from this station.

The energy required to operate the station is as follows:—

When Idle.—At such times the operating transformer and also the d.c. low-tension feeder contactors, of which there are eight (the neutral switches not being automatic), are alive.

Operating transformer	275 watts
Eight feeder contactors at 180.5 watts each	1,444 watts
Total	1,719 watts

When Operating.—At such times the operating contactors, in addition to the above, are all closed, making a total of 3,397 watts, and it was on the above figures that the operating cost of £93 was calculated.

In practice it is found that, although the voltage regulator keeps the pressure steady, it does not allow for a rise in pressure with increase in load, i.e., there is no compounding effect. This point in a manually operated station is taken care of by the operator, so that a contactor type of field regulator is being introduced, which is operated from the main ammeter shunts and which will automatically raise or lower the pressure 1 volt for every 100 amperes increase or decrease in load.

As stated above, numerous tests have been applied to prove the ability of the automatic gear to operate under faulty conditions, and its operation has been not only satisfactory but much more accurate and rapid than manual operation, the various relays being able to discriminate more rapidly than the human mind.

The author concludes with the hope that the information given, and the causes and considerations which led up to the decision of the Electricity Department to adopt automatic stations, may be of service and helpful to many engineers who may be hesitating as to the adoption of fully automatic stations.

The thanks of the author are due to Mr. H. Dickinson, the City Electrical Engineer of Liverpool, for per-

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mission to publish the information contained in the paper, and to Mr. L. Breach for his valuable assistance in the preparation thereof.

APPENDIX A.

RELAYS USED IN THE OPERATION OF THE STATION.

(1) Under-voltage relay.
(2) Low-voltage and time relay.
(3), (4) and (5) A.C. shunt relay.
(3a) A.C. shunt relay.
(6) A.C. starting contactor.
(7) Polarised motor relay.
(9) Field-reversing relay.
(10) 4 P.D.T. field contactor.
(11) A.C. running contactor.
(12) to (16) 1 250-ampere "C.B." contactor (line and resistance shunting).
(12a) D.C. accelerating relay.
(13) Series underload relay.
(17) 1 P.D.T. knife switch.
(18) Low-voltage and reverse-phase relay.
(19) A.C. shunt relay.
(20) Main oil circuit breaker.
(20a) No-voltage release.
(21) Low-voltage and time relay.
(21a) A.C. shunt relay.
(22) 125-ampere contactor.
(23) A.C. overload relay.
(24) Overspeed device.
(25) Bearing thermostat.
(27) Underload delay relay.
(28) Grid thermostat.
(29) Thermal time-element relay.
(30) Lock-out relay.
(31) Brush-lifting device.
(31a) A.C. shunt relay.
(31d) Brushes down.
(31u) Brushes up.
(32) D.C. reverse-current relay.
(34) and (35) Measuring relays.
(37) D.C. line contactor.
(37a) A.C. shunt relay.
(38) Field-current relay.
(40) and (41) Feeder contactor.
(46) Unbalanced phase-current relay.
(47) and (48) Time-lag opening relay.
(51) and (52) Overload relay.
(64) Automatic voltage regulator.

APPENDIX B.

A SHORT DESCRIPTION OF THE PRINCIPAL RELAYS USED IN THE OPERATION OF THE STATION.

(1) *Under-voltage relay.*—This is a simple solenoid-and-plunger type of relay in which, when energised, the plunger is drawn up into the coil. This plunger is connected at one end to a pivoted arm with a contact on the other end. The weight of the plunger is partially counterbalanced by a coil spring attached to the opposite end of the pivoted arm. This spring is used for adjusting the voltage at which the relay is required to operate. This type of relay is very sensitive and responds to slight changes in voltage.

(2) *Low-voltage and time relay.*—The main feature of this relay is to provide a short time-interval between the closing of contact (1) and the operation of master relay (3a). It is of the induction type and operates from a single-phase circuit. An aluminium disc is mounted in the air-gap between the poles of the laminated core. The shaft of this disc carries one of a set of contacts, and when the relay is de-energised these contacts are held open by a spring which rotates the disc until the movable contact strikes the top. When the relay is energised the torque overcomes the tension of the springs and the disc rotates until the contacts close. The movement of the disc is retarded by the damping effect of the disc as it moves between the poles of a strong permanent magnet. The time setting of the relay is changed by altering the position of the adjustable stop, which either shortens or lengthens the arc through which the disc must rotate before the contacts are closed. This time is adjustable from zero up to a few minutes. The construction of the relay also makes it a low-voltage relay, since, if the applied voltage is too low, the resulting torque will not be sufficient to overcome the pull of the spiral spring, and the disc will not rotate.

(7) *Polarised motor relay.*—This is a d.c. motor-driven relay, the armature of which is connected to the converter pilot brushes. The field is produced by permanent magnets. The motor drives the armature of a magnetic clutch through a series of reduction gears. When the clutch coil is energised, the clutch solenoid housing, which is mounted loose on the shaft, is drawn along until it engages with the clutch armature. Attached to the outside of the housing is an arm carrying the movable contacts. A spring mounted on the shaft keeps the clutch housing normally in such a position that this movable contact is held midway between the stationary contacts (7b) and (7d). The clutch coil is connected in parallel with the motor armature so that it engages and disengages simultaneously with the starting and stopping of the motor. When the proper voltage is applied to the motor it will start in the direction dependent upon the polarity of the armature circuit, and the clutch housing with the movable contacts will turn until contact is made with either (7b) or (7d), the top and bottom contacts. Immediately after the clutch relay is de-energised the clutch disengages and the spring returns the clutch housing to the mid-position. Contact with the clutch coil is made by two small fingers. Another set of fingers (7a) is bridged by a contact strip on the clutch housing when this is in the mid-position.

(18) *Reverse-phase, open-phase and low-voltage relay.*—This relay is very similar to relay (2) except that it is a polyphase instrument. The relay is connected in the circuit so that with normal phase rotation the contacts are held open against the tension of a spiral spring by the torque of the disc. If the phase rotation is changed, the torque will also be in the opposite direction and the contacts will be closed. Also, if an open phase occurs no torque will be exerted. Therefore a spring will rotate the disc and close the contacts. If the voltage drops below a certain value (usually 80 per cent.) the torque will not be sufficient to overcome the effect of the spring when the contacts are closed.

(21) *Time and low-voltage relay.*—This is an exact duplicate of relay (2).

(23) *A.C. overload relays.*—These are the standard induction-type overload relays, and their construction and principle of operation are very similar to those of relay (2), except for a few minor details. The relay is single-phase and the element is wound with a current coil instead of a potential coil. A number of taps (usually 6 or 8) are taken off the small current transformer and brought up to the terminal plate on the index scale. This gives the different current values at

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which the relay will operate and close its contact. The relay has an inverse time-element up to a certain percentage of the operating load, but for greater currents the minimum time required to close the contacts is practically constant.

(25) *Bearing thermostats.*—These consist of copper bellows connected through a small copper tube to a bulb which is embedded in the lower half of the bearing, where it will be subject to the maximum bearing temperature. The bulb and the bellows are partially filled with a liquid which vaporises at a given temperature. When the bearing reaches this temperature the bellows elongate owing to the pressure of the vapour, and the contacts are closed, and they remain in that position until reset by hand. Thus, in addition to tripping the lock-out relay, the inspector will have a positive indication as to which bearing was hot. The thermostats operate at approximately 90 deg. C.

(27) *A.C. underload delay relay.*—This is a motor-operated relay and consists of a small induction motor driving, through a spur-and-worm gear reduction, a disc which carries a moving contact. The function of the gearing is to provide a long, definite time-interval between the starting of the motor and the closing of the contacts. Intervals of from 3 to 30 minutes may be obtained. In addition to the slow-closing contacts (27T) there is a second set of contacts (27S) provided, which close momentarily at approximately 1½ minutes after the motor starts to revolve. These are the starting protective contacts which lock the station out if it fails to start within a given length of time.

(28) *Grid thermostats.*—These are practically the same as the bearing thermostats, the only difference being that they operate at a higher temperature. They will reset again as soon as the thermostat cools.

(29) *Thermal time-element relay.*—This consists of a number of bimetallic springs attached to a shaft which carries a movable contact. Current from the secondary of a current transformer in the low-tension side of the power transformer is passed through the bimetallic springs and heats them. The springs tend to unwind and in so doing the shaft is rotated and the contacts close. The element is mounted in a heat-insulated case which is filled with oil. The relay follows very closely the heating of the machine and is very efficient in protecting the converter from damage due to overheating. Mounted in the same case is a low-ratio transformer which gives the correct current in the relay, so that it will operate at the most satisfactory point on the calibration curve.

(30) *Lock-out relay.*—This relay has two pairs of contacts and a contact bridge which can make contact across either the lower or upper pair of contacts. In the normal position this contact bridge is latched so that the circuit is closed through the lower set of contacts. When the operating coil is energised the latch is released and a spring moves the bridge until it connects the upper pair of contacts and interrupts the circuit through the bottom pair. Once the relay has operated it must be reset by hand. A small target indicates white when the relay has operated.

(31) *Brush-lifting device.*—This consists of a motor connected through reduction gear to a brush-lifting ring on the converter. A jack-shaft carries four cams which operate four contactor switches. Two of these are limit switches which stop the motor when the brushes are in the correct position, either up or down, and the other two are interlock contacts, one of which prevents the converter from starting until the brushes are up and the other prevents the line switch from closing until the brushes are down. The motor is of the clutch type and does not pick up load until it is almost up to full speed. It is a single-phase motor and the split phase is used in starting.

(32) *D.C. reverse-current relay.*—This relay operates on the moving-coil principle, and is very similar to a millivoltmeter, except that all the parts are heavier and more robust. The relay is so connected that it will close its contacts only when current flows in the reverse direction.

(34) and (35) *Measuring relay.*—These, in connection with a suitable bridging resistance, automatically measure a short-circuit on the feeder when the breaker trips and determine when the conditions are such that the current will not be above a pre-determined value when the breakers re-close. The relays are very sensitive to changes in current and are capable of very accurate adjustment.

(46) *Phase-balance current relay.*—This is used to protect the converter against running single-phase. Relay (18) will only prevent the machine from starting up on a single-phase, and in the case of phase failure while the converter is running it would continue to run on single-phase and act as a phase converter and supply three-phase potential which would hold the contacts of relay (18) open. However, with relay (46) in the circuit it will operate when the phase failure occurs, and shut the station down. Then if the trouble is on the high-tension side relay (18) will close its contacts and prevent the station from starting until the three phases are normal. If the trouble should be on the low-tension side relay (18) will not operate, and the station can start up again. As soon as it attempts to start, relay (46) operates again. During starting the contacts of relay (46) are connected in the lock-out relay circuit, so that the station would then be locked out. This is a special polyphase induction-type relay and is operated from the secondaries of the current transformer in the low-tension circuit. If an unbalanced load, such as a phase failure, occurs, the torques produced at the different elements will not be the same and the relay contacts will close.

AMERICAN PRINTING TELEGRAPH INSTRUMENTS IN JAPAN.

According to the *Telegraph and Telephone Age*, of New York, printing telegraph equipment, which has a capacity of sending and receiving 2,400 letters per minute, is in operation on the Tokyo-Osaka-Nagasaki lines. The Japanese Government has purchased four outfits from the Western Electric Company through the Nippon Electric Company of Tokyo. Commenting on the installation, the Osaka-Mainichi *News* says that telegraph messages will be sent over the new system in Roman characters. The messages are transcribed on a standard typewriter keyboard at the sending end on to a perforating tape. This tape controls the sending of electric impulses out on the line, which actuate an electrical typewriter at the distant end and reproduce the message on regular telegraph blanks ready for delivery, with a carbon copy for office records.

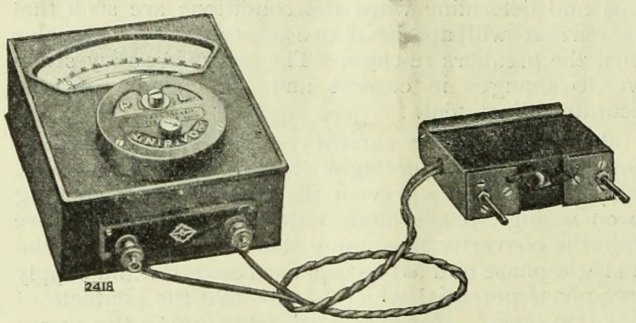
Many hundreds of miles of message circuits are equipped with these printers in the United States, and

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it is an interesting evidence of the progressiveness of the Japanese Department of Communication that they are equipping their two most important lines with these up-to-date devices.

CAMBRIDGE ACCUMULATOR TESTER.

The particular function of the Cambridge Accumulator Tester, illustrated below, is to detect the presence of a short circuit between two adjacent plates of a large accumulator. The instrument consists of a sensitive and robust unipivot galvanometer giving a sensitivity of 240 micro-amperes for full-scale deflection, connected by a short length of rubber-covered



leads to a pair of ebonite contact spikes mounted on a suitable hard-wood holder. The test is carried out by pressing the two contact spikes on to the current-carrying lugs, and the presence of a short circuit is instantly recognised from the deflection on the galvanometer. A second scale can be added enabling the instrument to be used also as a voltmeter. The outfit is compact, simple to use and accurate in performance.

PRACTICAL ENGINEERING.

We have on many occasions referred to the Crystal Palace School of Practical Engineering and the excellent training which is given to the pupils who serve their time therein. Particular emphasis was given to this fact on the occasion of the twenty-second dinner of the old students' society which was held at the Criterion Restaurant on Wednesday, the 16th inst. The chair was occupied by the president for the year, viz., Mr. Henry E. Stilgoe, M.I.C.E., who is the chief engineer to the Metropolitan Water Board, and he was supported by Sir Cyril Kirkpatrick, chief engineer to the Port of London Authority; Mr. R. I. Money, M.I.C.E.; Mr. Alfred Pearce, M.I.C.E., and numerous other old students holding high positions in the profession. Needless to say, the toast of "The School," which was ably proposed by Mr. Maurice Fitzgerald Wilson, was received with acclamation, and it was responded to by Mr. J. W. Wilson, the principal, who referred with pride to the fact that the school has passed its jubilee, and he could look around the tables and see proof of the results which had been achieved in the way of eminence and reputation, due to the thoroughness of the training which had been imparted by his father and himself. Mr. G. J. Furness, M.P., was another old student, and he was to have proposed "The Crystal Palace Old Students' Society," but he could not get away from his Parliamentary duties, so sent a telegram of congratulation instead; while Sir Ernest Moir, Bart., who later responded to the toast of "The Visitors," told us some interesting facts in regard to the construction of the East River Tunnel at New York and concluded with a humorous Scotch yarn. Toasts of "The Ladies," "The Dinner Committee" and "The Chairman" were also duly honoured, and the whole evening passed off very pleasantly indeed.

INSTRUCTION IN ELECTRICAL ENGINEERING.

We have received a handbook of the course of instruction by the Cambrian Correspondence Electrical School, Porth, offered to prospective students who wish to study by the correspondence method. As indicated, the instruction is conducted through the post, the instruction papers, question papers, answers, etc., being sent to the student according to the progress he makes. The student studies the instruction papers or lessons —which are prepared so that he will find no difficulty in comprehending every point—and having mastered these he takes up the question paper, which contains questions and examples on the subject matter of the lesson. These the student answers and works to the best of his ability, and posts to the school, where his answers are examined. The course covers the subjects that candidates for the Association of Mining Electrical Engineers, Board of Education, and all grades in Electrical Engineering of the City and Guilds Institute Examinations, have to know, both in theory and in practice, and deals with them in a manner designed to thoroughly prepare the students for the examination they have to face. The treatise is very comprehensive, and takes the student through all the subjects appertaining to magnetism, electricity and electrical engineering, electrical mathematics and mathematics, telephony, telegraphy and wireless.

The system of education by correspondence is growing in this country, perhaps because it has the supreme advantage of keeping the student close at his work. Men reading in the ordinary way for exams. may do just as much or as little as they please: but when they are forced, on pain of getting no value for their tuition fees, to reduce their work to writing, scamping and superficiality become well-nigh impossible. Mr. William Thomas, the well-known consulting engineer, is the head of the school, and a large number of testimonials have been received testifying to the benefits which have been received from the institution. There are many ambitious and studious young men who have profited by the systematic course of instruction which the principal has laid down. Mr. Thomas makes a point of maintaining the highest possible standard of specialised instruction. We can recommend this school to the favourable consideration of parents and pupils, because we have been afforded the opportunity of proving that the results achieved have been, session after session, uniformly and consistently good.

International Trade Fair.—According to the *Board of Trade Journal*, the third International Trade Fair will be held at Laibach, Jugo-Slavia, from September 1 to 10, and it is understood that there is a market in that country for electro-technical and other machinery. This should be of interest to English manufacturers and exporters.

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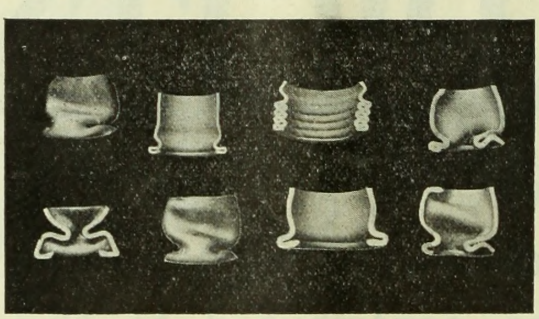
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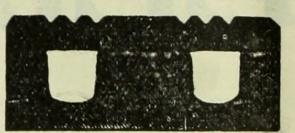
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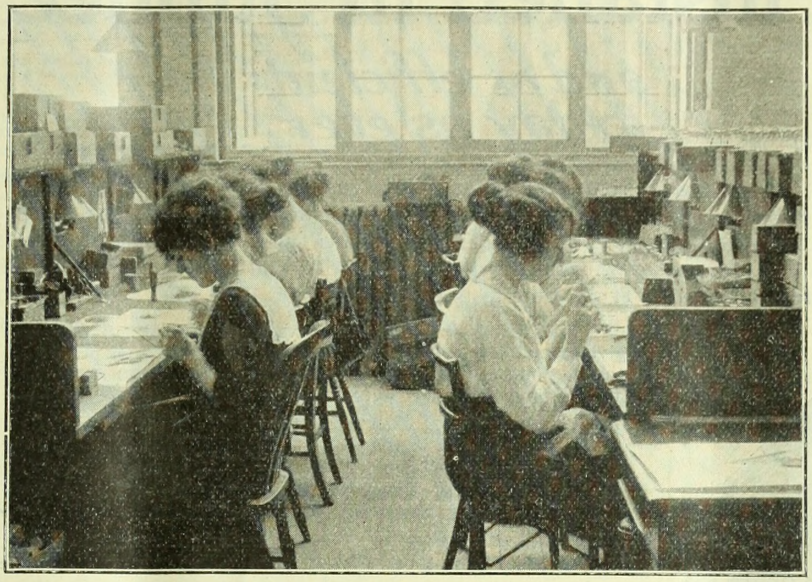
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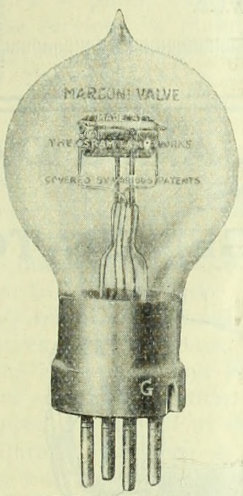
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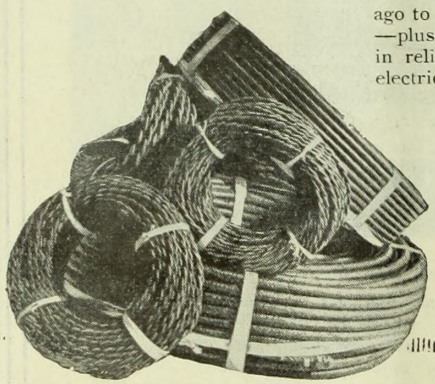
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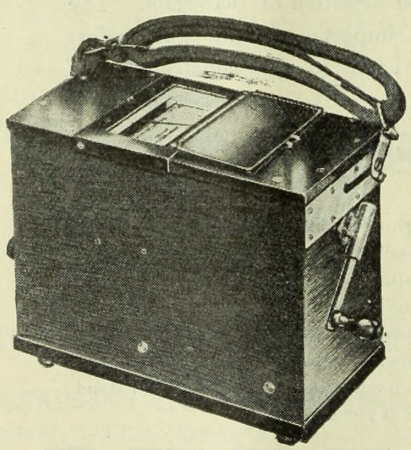
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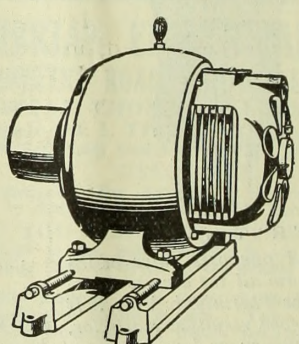
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Current Topics.

Declining Tramways.

That the age of tramways is passing and gradually merging into that of another similar system of transportation known as light railways has been obvious for some time past. The ordinary street tramway has served its purpose, and an admittedly invaluable one, in the past quarter of a century, but modern traffic conditions are rapidly making it increasingly difficult for these systems to hold their own. From a financial standpoint there are very few tramway systems in this country which even pay their way, as instance a statement at a recent meeting of the Liverpool City Council that no less than fourteen out of thirty routes in that city were being run at a loss. In these lean years, when every effort must be made to effect economies in public expenditure, it is essential that only those services be maintained which at least pay their way, and do not constitute an additional charge upon the already grievously overburdened ratepayer.

In its editorial columns, my contemporary, the *Tramway and Railway World*, ventilates another grievance under which these undertakings are at present labouring, and which, under existing circumstances, it is difficult to remove without adding yet another burden to local taxation. It is the question of permanent-way maintenance and, in the case of new extensions, increased prime cost. It seems that tramway authorities are still bound by a condition of the Tramways Act of 1870, section 28 of which enacts that: "The promoters shall at their own expense, at all times, maintain and keep in good condition and repair . . . so much of any road whereon any tramway belonging to them is laid as lies between the rails of the tramway and . . . the portion of the road between the tramway, and in every case so much of the road as extends eighteen inches beyond the rails of and on each side of any such tramways."

It will be seen that, under this obsolete enactment, every tramway undertaking is responsible not only for the actual steel track, but also for the foundations of the track and a portion of the roadway eighteen inches on either side of the extreme limits of its rails. Although quite a reasonable provision at the time the Act was passed, and when our streets were only subject to horsed and pedestrian traffic, it now places the tramways under an ever-increasing expenditure due to the very largely increased wear and tear of the surface of the roadway, and, in addition, the extra strain thrown upon its foundations due to the very much heavier loads imposed by motor vehicle traffic. To compensate this additional wear and tear on the roads over which no tramway tracks are laid, the local authorities receive grants from the State Roads Fund, derived from the taxation of motor vehicles. Tramways, on the other hand, have no such redress, and it is manifestly impracticable to impose an additional burden upon the taxpayer to meet this contingency.

According to the general secretary of the Municipal Tramways Association, a conference was held in April between representatives of that association, the Scottish Tramways Association and the Association of Municipal Corporations, at which this vexed question was examined at close quarters. At the meeting of the council of the Municipal Tramways Association, held on April 13, it was further considered, upon a report of that conference and in the light of it, and agreed that no feasible scheme was at present possible which would achieve the object in view, i.e., afford relief to municipal tramways without at the same time impoverishing the local authority. The modern tendency in the suburban districts of larger cities to lay sleeper tracks along fenced routes distinct from the public highway, of course, overcomes the difficulty, and incidentally converts the tramway into a light railway, and rids it of all the disabilities and drawbacks incidental to the same system in the busier thoroughfares.

Smoke Abolition.

If only they tackle the problem from the right end and do not attempt to eliminate the smoke nuisance by ineffective and impracticable legislation, the next generation may come within sight of that smokeless and fogless Utopia of which so many of us have dreamed since the gospel of universal electrification was first preached. The Public Control Committee of the London County Council once more states the already well-known fact that the domestic chimney is undoubtedly one of the causes of atmospheric pollution. The practical consideration is whether a remedy can be found under existing conditions. In the Committee's view there is none beyond inducing housebuilders to employ types of grates and grate settings that have been found by experience to be effective for warming purposes and largely smokeless when burning bituminous coal, or to which electrical appliances, gas stoves or gas cookers can be fitted satisfactorily and with due regard to appearance.

The Committee further express the opinion that the time has arrived when the use of the old-fashioned kitchener might well cease. As compared with modern electric and gas cooking appliances it is inefficient and out of date, and probably wasteful of fuel. It must be held responsible for a very large proportion of the smoke arising from domestic chimneys. Glasgow Corporation goes a step further, and has inaugurated at Dowanhill a block of all-electric flats, rendered possible by the conversion of a big West-End mansion. In these flats the latest electrical cooking, heating and labour-saving devices have been installed, and are on exhibition for a fortnight to demonstrate to Glaswegians the possibilities of attaining to a smokeless Glasgow by the aid of the Corporation electricity supply.

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All these individual efforts, however, whilst highly gratifying to those of our industry who have contributed to modern smokeless heating and cooking, bring us little, if any, nearer to an ultimate solution of atmospheric pollution on anything like a wholesale scale. You may build and equip all-electric houses for a century or more, and even impose by-laws prohibiting the use of open coal grates or inefficient kitcheners in newly built property, but the comparatively small measure of reform thereby effected will not materially reduce the smoke clouds which hover over London or any other large city, and which are caused by the soot projected into the atmosphere from the tens of thousands of *existing* old-fashioned grates and kitcheners which no amount of housing reform or electrical and gas cooking and heating propaganda will ever entirely displace.

The change, if it is to come about, must inevitably be gradual, and we shall all have to continue hammering away at the problem of educating the newer generations into adopting the more modern heating and cooking methods until such time as the housing problem is less evident, and tenants are able to exercise the prerogative of choice in selecting their residences. In this all-important campaign, which is in the best interests of public health and well-being, the electricity supply authorities will have to play an equally important part, for electricity must be cheapened still further before its use for the purposes named comes within the range of practical politics where the middle and working classes are concerned. The comparative cheapness of coal, and the simplicity, albeit wastefulness, of the familiar method of using it in the average household, is at present one of the greatest obstacles to a more rapid conversion to modern smokeless principles in domestic heating and cooking.

Elektron.

A.C. NEUTRAL POINT EARTHING.

By S. Austen Stigant, A.M.I.E.E., M.Am.I.E.E., Member J.Inst.E.*

(*Continued from page* 261).

The earthed neutral point.—The advantages of earthing the neutral point are manifold, and the principal ones may briefly be referred to as follows :—

1. Persistent arcing grounds are eliminated, and an earth fault becomes definitely converted into a short circuit from line to neutral. The high-pressure oscillations which are so prevalent in systems having insulated neutrals, and which have caused so much damage on such systems in the past, are reduced to a minimum, and consequently the factor of safety of the system against earth faults is largely increased. This reasoning applies to systems having both overhead lines and underground cables, though to a greater extent with the former.

2. Earthing the neutral point secures the maximum effectiveness of automatic protective gear immediately an earth fault occurs on the system. In H.T. networks most of the line faults take place to earth, particularly where such networks consist of underground cable, and on a system employing an insulated neutral these faults would generally take the form of an arcing ground, which, in the case of multi-core cables, would result ultimately in a severe short circuit between phases. The earthed neutral, in conjunction with automatic protective gear, results in the faulty section becoming isolated in the incipient stages of the fault.

3. If the neutral point is dead earthed, high-pressure shocks to the system and apparatus connected thereto are reduced to a minimum, as the pressure to earth of any live conductor cannot exceed the voltage from each line to neutral. As under such conditions the neutral point will be at zero potential it is possible to effect appreciable reductions in the insulation to earth of cables and overhead lines, which produce a corresponding saving in cost. It is also possible to make similar insulation reductions in transformers and generators, but in practice this is carried into effect only in very high voltage transformers in which the insulation is graded down from the line terminals to the neutral point. In generators and in transformers wound for ordinary distribution and transmission pressures (such, for instance, as are adopted in Great Britain) the insulation usually is not graded, the benefit being obtained instead of an increased factor of safety.

A dead earth fault on one line of a system having an insulated neutral, raises the pressure of the two sound lines to full line pressure above earth, which is maintained so long as the fault remains. The insulation of all apparatus connected to the lines is subjected to this high pressure, and, although it may be able to withstand the first few shocks, it will eventually fail from cumulative weakening action. In very high voltage systems, on account of their electrostatic capacity, the pressure of the two sound lines may, at the first instant of the fault, reach a value approaching twice the normal line pressure by the same phenomenon as the double over-charging which takes place when switching a pure capacity into circuit, and the insulation of the system will be correspondingly affected.

4. When earthing the neutral point it is not essential that this should be done direct, and, in fact, in H.T. systems having large generating capacities it is usual to insert some current-limiting device between the neutral point and earth. By this means the current flowing upon the occurrence of an earth fault can be limited to such a value as will, with a certain margin, operate the protective relays, while at the same time lightening the duty on the oil switches and reducing the electromagnetic stresses on those parts of the system which would be subjected to the influence of the fault current.

In connection with this aspect it is interesting to point out that the American power companies transmitting at the highest pressures are in most cases operating with the neutral point dead earthed, and it would appear that this is largely due to the fact that while considerable amounts of power are being transmitted the transmission voltages are so high that the fault currents flowing, even with a dead earthed neutral, are not sufficiently large as to produce such electromagnetic stresses on the system as cannot adequately be taken care of by more or less simple provisions in the mechanical design of the apparatus concerned. In addition, these very high pressures can only be transmitted by means of overhead lines, and as these embody an appreciable amount of inherent reactance the short circuit current is still further reduced.

* Paper read before the Junior Institution of Engineers.

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5. On an unearthed system the pressure to earth of any line conductor may have any value whatever up to the breakdown pressure of the insulation to earth, even though the normal pressure between lines and from lines to neutral is maintained. Such a condition may easily arise by means of electrostatic induction on systems employing overhead lines, as these are particularly subject to induced static charges from adjacent charged clouds, dust, sleet, fog and rain, and to changes in altitudes of the lines. If provision be not made for freeing the line from these induced charges, gradual accumulation takes place, and the line and apparatus connected to it reaches a high "floating" potential above earth until the abnormal condition is relieved by a breakdown to earth of the line or machine insulation or by the flashover of lightning arrester gaps.

If, however, the neutral point is earthed either direct or through a current-limiting device, the induced static charges are conducted to earth as they appear, and all danger to the insulation of the line and apparatus is removed. Therefore, no part of a dead earthed neutral system can reach a pressure above earth greater than the normal pressure from line to neutral.

6. While the foregoing remarks apply generally to the earthing of H.T. and L.T. neutral points, it is pertinent to consider L.T. neutral point earthing with respect to the Home Office and Coal Mines Electricity Regulations. Regulation No. 20 of the Home Office Electricity Regulations of the Factory and Workshops Acts read:—"Where a high pressure or extra high pressure supply is transformed for use at a lower pressure, or energy is transformed up to above low pressure, suitable provision should be made to guard against danger, by reason of the lower pressure system becoming accidentally charged above its normal pressure by leakage or contact from the higher pressure system."

The requirements of the Coal Mines Act concerning H.T. neutral point earthing are specified in Regulation 126 (b), which reads:—"Where energy is transformed, suitable provision should be made to guard against danger by reason of the lower pressure apparatus becoming accidentally charged above its normal pressure by leakage from or contact with the higher pressure apparatus."

The above regulations have been framed with two principal ideas in mind: first, that the earthing of the L.T. neutral will prevent the presence of any pressure above the normal appearing in the L.T. circuit, and therefore the possible danger to human life is reduced to a minimum; and, second, the earthing of the neutral point eliminates the possibility of an arcing fault to earth, and therefore of fire risk, while it also ensures the rapid disconnection of faulty apparatus from the system without undue delay. A study of these regulations and of the explanatory memoranda issued by the Electrical Inspector of Factories will convince one that the L.T. neutral point is earthed chiefly for reasons somewhat different to those influencing the earthing of the H.T. neutral. In the latter case the neutral is earthed mainly for the sake of the protection afforded to the electrical system, while in the former case the neutral is earthed chiefly in order to reduce to a minimum the possible danger to human life should contact accidentally be made with any live low pressure conductor.

Neutral Earthing Apparatus.—The choice of suitable apparatus for inserting in the neutral connection for the purpose of limiting earth fault currents is dependent partly upon the pressure of the system to be earthed, that is, whether it is H.T. or L.T., partly upon the k.v.a. output of the system and the arrangement of generating plant, and largely upon the idiosyncrasies of the engineer responsible for the installation. The neutral point may, in the case of H.T. systems, be earthed direct or through a resistance, untuned reactance coil, or a tuned or partly tuned reactance coil. The untuned coil, generally, simply has an impedance of such a value as to cause the operation of relays at certain desired fault currents, while the tuned or partly tuned coils go further than this, in so far that an endeavour is made to reduce the earth current to such a value as will not cause restriking of the fault arc. Such coils are notably the Petersen earth coil and the dissonance coil, and it will be seen subsequently that the application of these coils is distinctly limited. While the insertion of some current limiting device is beneficial from the point of view of reducing fault currents, it should be remembered that the sound lines may, for a short period of time, be subject to pressures higher than the normal phase pressure; but if the automatic protective gear operates sufficiently rapid, the actual effects of such increases in pressure are not of serious import.

Dealing first with the H.T. neutral, this may be earthed direct if the short circuit fault current of one phase is only of the order of the current necessary to operate the protective relays, or if the flow of the fault current only produces such electro-magnetic stresses in the system apparatus as can easily be provided against. As remarked earlier in the paper, it is worthy of note that in the U.S.A. the neutral points of a large proportion of the systems transmitting at 66,000 volts and above are earthed direct without the insertion of any current limiting device, though, on the other hand, almost as large a number operate (at present) with the neutral point insulated. The latter procedure is probably a transitional stage only.

By far the most common device used in connection with H.T. neutral point earthing is some form or other of resistance which usually, though not always, takes the form of cast or pressed grids. The actual ohmic value of the resistance bank depends upon the highest relay setting, and they are often designed to carry for about 30 seconds a fault current equal to one and a half to twice the estimated heaviest current necessary for operating the least sensitive relay. These resistance banks are usually air cooled, but on the European Continent they sometimes take the form of resistance wire wound non-inductively upon insulating tubes and mounted upon suitable framework, the whole being immersed in oil. While resistances have the desirable quality of tending to damp out surges, they are usually a source of intense dissatisfaction from the point of view of both price and bulk. For a given line pressure the price and dimensions increase considerably with reduction in ohmic value, as, of course, the fault current to be carried is in inverse proportion to the ohmic value of the protective resistance.

A certain disadvantage of the ordinary grid or wire resistance is that it possesses a positive temperature coefficient so that as the temperature increases with the time of current flow, the resistance also increases and the fault current decreases, and if the initial fault current was not sufficiently great to operate the relays the

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fault would persist and possibly cause more extensive damage; if, however, the value of the resistance is chosen to allow sufficient margin over the heaviest current required to operate the least sensitive relay, this disadvantage is more apparent than real.

There is available, however, a resistance having a negative temperature coefficient, so that the fault current, instead of decreasing with time, increases, and it is claimed for this resistance, which is known as the Brazil carbon powder resistance, that the fault current need never exceed the current necessary to trip the least sensitive relay, and consequently excessive electromagnetic stresses on the system apparatus are avoided. On the other hand, it is the opinion of certain operating engineers that if the first kick of the fault current does not trip the relays, a gradually increasing current will certainly not do so, but instead the fault will be prolonged and the damage become more extensive.

At least one important electricity undertaking earths the E.H.T. neutral point through a large water resistance. The particular one the author has in mind is rated at 20 ohms, the line voltage being 20,000, and this resistance has given every satisfaction. The water is stationary, and the apparatus must not be confused with the smaller water jet earthing resistances often used on the European Continent for neutral point earthing.

In Great Britain untuned reactance coils have been used to some slight extent for earthing generator neutral points, and these coils have generally taken the form of multi-core lead covered cables cast in concrete. The multiple cores inside the single lead sheath are really all connected in series to form the total number of turns necessary to give the desired reactance, and the next slide shows such a coil. The coils are connected up to the circuit by means of single core lead covered cable, and as the sheath can be earthed there is no danger of shock to station attendants under fault conditions. Another type of reactance coil consists of bare stranded conductors wound upon an insulating framework and finally enclosed by protecting porcelain blocks, the whole being mounted between substantial case end plates and supported upon porcelain insulators.

On the European Continent, and to some extent in America, generator neutral points have been earthed through tuned or partly tuned reactance coils known as Petersen earth coils and dissonance coils respectively. The coils are designed so as to resonate at fundamental frequency more or less exactly with the resultant capacity of the system when an earth fault occurs on one of the lines. With an earth fault on the system the earth coil is in parallel with the resultant capacity of the system, and if the coil is designed for close resonance, a large current will circulate through the earth coil and the line capacities, but the current flowing through the actual fault will have a very small value only, as it is the vector difference of the current through the coil, and the current through the system capacities which are almost 180 degrees out of phase with one another. Theoretically the most favourable conditions for the proper action of the earth coil, that is for the suppressing of arcing grounds, are perfect resonance and low losses in the resonant circuit, and originally Petersen earth coils were designed to meet this condition as closely as possible. There is, however, difficulty in accurately resonating the earth coil with the line capacities under *all* fault conditions on long high voltage lines, and as a consequence the earth coil appears likely to be limited to systems employing medium pressure lines of relatively short lengths. It has been found in practice that it is not necessary to obtain anything like close resonance for the satisfactory operation of these earth coils, and coils having as much as 50 per cent. dissonance have been found to provide the necessary protection.

It will be seen that the function of the earth coil is twofold, first, and most important, to kill an arcing ground, and second, to pass sufficient current to trip the protective relays. The external appearance of this coil is similar to a static transformer having section wound coils. The apparatus, of course, has a single winding only, and is provided with a number of tappings so that the reactance can be varied to suit the capacity of that part of the system with which the coil is operating. The coil is oil immersed and placed in an ordinary transformer tank, and is rated at about 130 amperes for use on a 66 kv. circuit. Unlike the ordinary power transformer, this coil has an air core.

The neutral point of L.T. three-phase systems is usually earthed at the step-down transformer, and this earthing is effected in a variety of ways. In some cases the neutral point is earthed direct without the inclusion of any auxiliary apparatus, while in other cases it is earthed through some form or other of static earthing device. In other cases the neutral point is earthed through a resistance or through an ammeter and fuse, so that indication is given of the leakage current to earth. The advantage of direct earthing is that no pressure higher than the normal L.T. phase pressure can appear in the L.T. circuit, and consequently the risk of shock is reduced to a minimum. This applies irrespective of whether the H.T. winding breaks down to the L.T. or an electrostatically induced pressure is liable to appear on the secondary winding. In regard to the pressure distribution on the H.T. side with respect to earth when a breakdown occurs on one phase of a transformer from H.T. to L.T. windings, it is the H.T. windings only which reach abnormal pressures above earth; so long as the L.T. neutral is earthed direct, pressure distribution in the L.T. windings remains unaltered.

It is sometimes urged that with the neutral point direct earthed the danger from shock is increased as contact with any one of the line wires produces a more or less high resistance short circuit across one phase, and the fault current is relatively large; if the neutral point is insulated or earthed through an earthing device the current momentarily flowing when making contact with one line conductor is the charging current of the system. It is the author's opinion that no definite ruling can be laid down upon this point, as it is largely a question of the health of the individual concerned and of the particular local conditions existing at the time. There are many cases known to operating engineers of individuals having survived shocks from alternating pressures as high as 20,000 volts, others succumbing to pressures as low as 110 volts.

(To be continued.)

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THE ELECTRICAL EQUIPMENT AT THE THEATRE ROYAL CINEMA, MANCHESTER.

The Theatre Royal, Manchester, after a celebrated past, has, as most of our readers are aware, gone over to the pictures. The following details of the electrical equipment are, therefore, of interest.

Power is brought into the building from the Corporation mains, and is transformed from 400 volts D.C. to 100 volts D.C., by motor generator sets for the operation of the projector arcs. The general distribution to the various parts of the theatre where power is required is by means of the Unit-type Ironclad Switchboard shown in Fig. 1. This board is largely in accordance with standard practice, and affords an interesting example of the adaptability of the Unit-type arrangement.

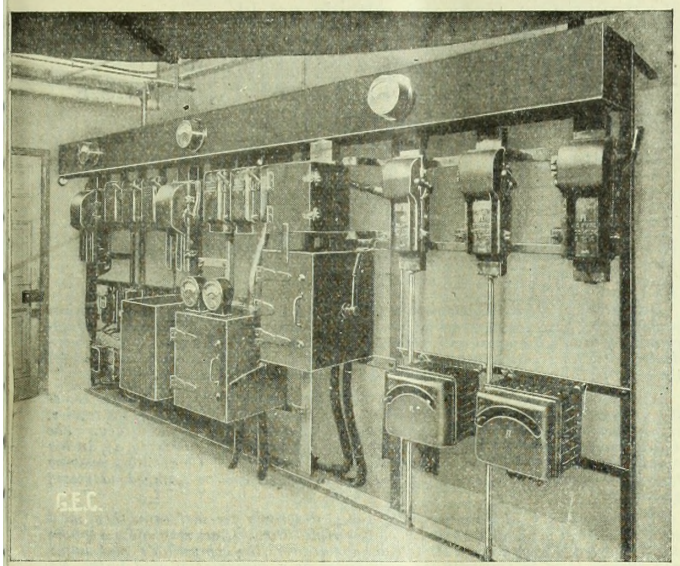


FIG. 1.—GENERAL VIEW OF UNIT-TYPE IRONCLAD SWITCHBOARD CONTROLLING THE WHOLE OF THE ELECTRICAL SYSTEM IN THE THEATRE.

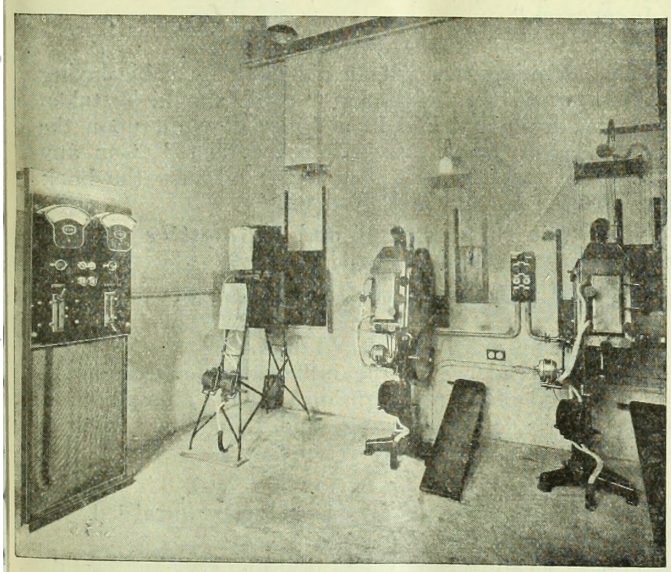


FIG. 2.—GENERAL VIEW OF THE PROJECTION ARCS IN THE OPERATING ROOM.

The main points of interest centre in the Bioscope Control Room, shown in Fig. 2, and the contactor panel, which automatically regulates the workings of the projector arcs.

There are three bioscopes; close to each of these is a panel on which are mounted seven press buttons (Fig. 3). Each of these controls (1) a projector arc, (2) dimmers for the main lighting in the theatre, and (3) the curtain and bells. Thus the whole control is in the hands of the operator, who does not have to move away from a projector which he is using at any given time, the voltage regulator being set before the arc is struck. This resistance controls the arcs of all three projectors.

Two bioscopes are always connected to the resistance, the arc of one burning brightly for the film being shown, the other cratering slowly for the film to follow, or with raised carbons. One is kept in reserve.

Two of the press buttons (Fig. 3) control the projector arc. One is labelled "Raise Arc," and the other "Lower Arc." The buttons are pressed to increase or decrease the intensity of the arc as required, but any increase in the operating arc always produces a corresponding decrease in the cratering arc, due to the fact that both arcs work from the line resistance. It is clear, therefore, that when the second bioscope is brought into use the operator has only to press the "Lower Arc" button of the projector in use, and simultaneously the brightness of the incoming bioscope will be raised to any desired degree. The arc press buttons control a line resistance through a small reversible motor, one button operating the motor in one direction, and the other in the reverse, the line resistance being inserted in series with the arc or out of circuit according to the direction of rotation of the motor, and decreasing or increasing the brightness of the arc as required.

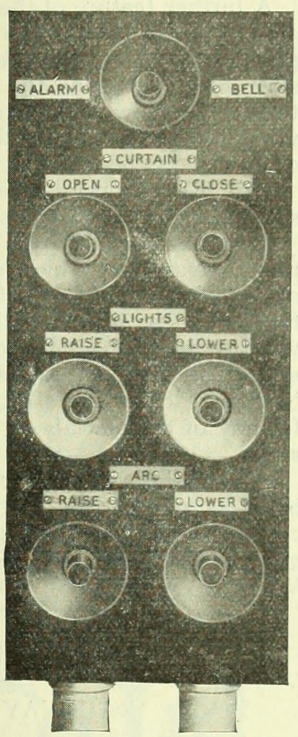


FIG. 3.—PUSH BUTTON PANEL ONE IS ADJACENT TO EACH LAMP.

Two other of the push buttons are used for controlling the dimming of the theatre lighting. Here again the push buttons control a small reversible motor, this in turn controlling the dimming resistance. Once a button has been pressed, the action of the dimmer goes on continuously through the medium of automatic contactors until the lights are out. A noteworthy feature in connection with the dimmers is the employment of contactors to short circuit the dimming resistance by the pressure of emergency lighting buttons, in various parts of the theatre. This will instantly restore the

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lights to their full brightness in case of emergency, irrespective of the control of the bioscope operator.

Two of the remaining buttons are used for the control of the curtain motor, and once a button has been pressed the action of raising or lowering the curtain goes on continuously until finished; a set of press buttons at the stage front also allows the operation of the curtain in a similar manner.

The last of the seven buttons is to attract the attention of the engineer in the basement power-room in the event of any failure in the supply.

The press buttons used for the above controls are of special design, and are fitted with shielding caps of various colours to avoid any possibility of error in operation.

In the operators' room a small panel is fitted provided with special change-over switches to allow Nos. 1 and 2, Nos. 2 and 3, or Nos. 1 and 3 projectors to be used as desired. These change-over switches are arranged so as to select and operate the contactors controlling the connections of the projector arcs and line resistance; time limit relays are also provided to give efficient protection against overload.

A further feature of the operators' panel is the provision of press buttons for controlling the voltage supplied to the arcs, these buttons control a small reversible motor operating the shunt regulator of the generators, and allow the voltage to be varied as desired, while two sector-shaped instruments allow observation of both voltage and current.

Suitable interlocks have been fitted wherever necessary, making the operation reliable and mistake proof.

It will be realised from the foregoing description the many advantages which are possible by the installation of electricity in cinema theatres, especially in view of the extremely simple methods of control, the whole of which is in the hands of one man. Equally it must be appreciated that in case of emergency the various push buttons in other parts of the theatre render it possible for any of the officials or attendants to take emergency steps.

The whole installation was designed and carried out by Messrs. Bartrum, Roylance and Co., Ltd., of Manchester, while the motor-generators, automatic control gear, switchgear, etc., were manufactured at the Witton Works of the General Electric Co., Ltd.

Correspondence.

RAILWAY GROUPING.

To the Editor of ELECTRICITY.

SIR,—Your reply in "Current Topics" on May 4 contains statements with which I am unable to agree.

You say, "Mr. Tweedie will, I think, be the first to admit the difficulties of making progress with new ideas in face of . . . managerial red tape and tradition, inseparable from any such extensive organisation as the one with which he is associated."

I am engaged on new ideas most of my time, and I most emphatically refuse to admit the difficulties described above.

As regards tradition, the tradition I have met is to try every device or appliance which seems likely to be an improvement, whether it is suggested by a high officer or by a worker in the lowest grade, or by an outside firm.

Every member of the technical staff of a railway will be grateful to you for your effort to improve their position, which they will hope will be successful. There certainly is a tendency amongst non-technical departments to forget that a railway is at rock bottom a most complicated piece of transportation machinery, employing applied science in every form, and that a considerable degree of education and experience is required by the technical staff, which education has to be brought in from the outside world.

Certainly where this is not recognised already there is room for improvement.—Yours faithfully,

M. G. TWEEDIE, A.M.I.E.E., M.I.R.S.E.

"Audley," Oxford Road,
Tilehurst, Berks.

May 14, 1923.

Questions and Answers by Practical Men.

RULES.

QUESTIONS: *We invite our readers to send us questions, preferably on technical problems that have arisen in actual practice. Questions which we consider of sufficient interest to our readers will either be replied to under "Answers to Correspondents" or replies will be invited from our readers. One shilling will be paid for the question which we select for competitive replies in this column.*

ANSWERS: *A fee of 10s. will be paid for the answer which we consider shows the greatest merit, and 5s. for the one we select as second best. In judging the replies, importance will be attached to clearness and conciseness, as well as accuracy. The Editor reserves the right to make no award, or to accept only one reply, if, in his opinion, the answers received do not possess sufficient merit. Competitors desiring the return of their manuscripts, if unaccepted, should enclose stamped addressed envelope.*

Write on one side of the paper only, and if diagrams are sent, draw them on a separate sheet of paper attached to the manuscript. Competitors may adopt a "nom de plume," but, both in the case of questions and answers, the competitor's real name and address must be sent with the manuscript as a guarantee of good faith. No correspondence will be entered into with regard to successful replies. The Editor's decision is final.

Commencing with Question No. 101, a Diploma of Merit will be awarded to the six competitors who win the first or second prize the most times during the next twelve months.

The words "Questions and Answers" or "Q" and "A" should be placed at the top left-hand corner of all letters intended for this column.

QUESTION NO. 159.

I wish to decrease the speed of a direct current motor under my charge. I desire to do this without the insertion of resistances, which I understand are very wasteful. How can I most efficiently do this? The motor is 40 h.p., 220 volts, compound wound.—"INSPECTOR."

QUESTION NO. 160.

When looking through an old book on cable laying I came across the expression "cable should be taken from the drum and laid in a figure of eight upon the ground before being drawn into the duct." Can any reader tell me why this should be, because the book does not tell me why?—"JOINTER."

(Replies to Questions 159 and 160 must be received not later than May 26, 1923.)

Answers to Questions.

QUESTION NO. 156.

Can any reader give me information concerning a good method of indirect lighting? I have a small study where I do a lot of drawing, and I find the ordinary electric light is very trying for my eyes.—"Pen."

REPLY TO QUESTION NO. 156.

The first prize (10s.) has been awarded to "Astatic" for the following reply:—

Indirect lighting cannot be said to be very successful, since it has been tried for many years without good results. One form of indirect lighting, and one used

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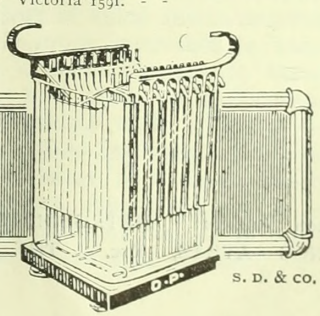
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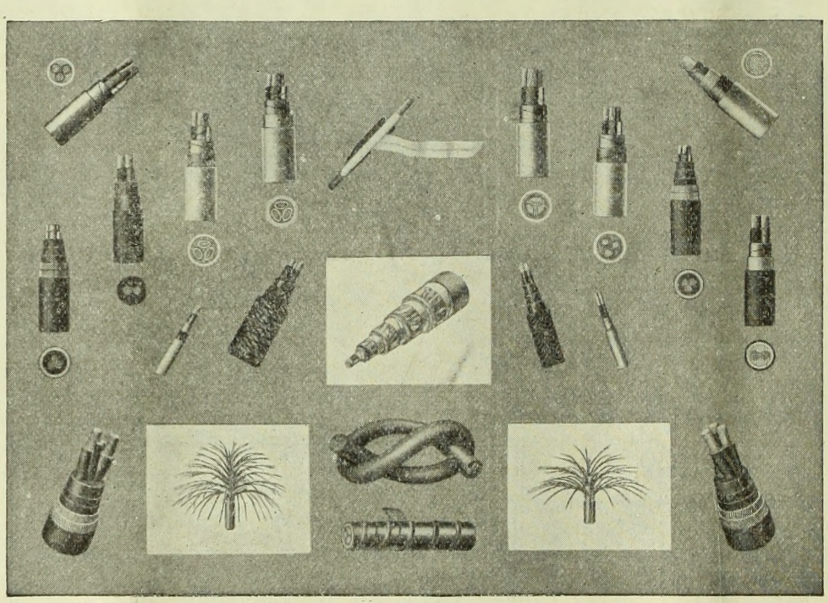
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in several large Government drawing offices, is to place direct current arc lamps a certain distance from the ceiling with white reflectors under the opalescent globe. The object is to reflect the light on to the ceiling from which it is again reflected into the room.

"Pen" mentions that his study is a small one. This being so, I really cannot see that any exceptional system of indirect lighting is necessary. Arc lamps would not only be superfluous, but very expensive, from the fact that, in addition to the cost of the lamps, it is probable that the wires are not of sufficient cross sectional area to carry the current required by arc lamps. Again, it is possible that the system of supply is alternating. In this case a rectifier would be necessary or the light reflection from the lamp would be alternately on the ceiling and the reflector

One might suggest the installation of mercury vapour lamps, that is, if the supply is one of direct current. Here again, however, the cost and the size of cables are the chief consideration. One fact, however, is the suitability of the mercury vapour lamp upon the person using the drawing instruments. That is, the greenish light does not suit everyone.

The amount of light necessary to use the instruments efficiently is not a standard factor, since this depends upon the person at work. Some persons can draw much better than others with only half the light. From this it would appear to be a matter of the elimination of the "glare" and the position of the light.

"Pen" should try a large frosted lamp in the lamp-holder. Frosted lamps of the metal filament type are now available in all candle-powers. This would dispose entirely of the glare, and the light thrown on to the paper would be quite mellow, but the shadows would not be entirely eliminated. In any case there is bound to be a certain amount of shadow thrown on the paper if only from the instruments used.

This would suggest that the light should be placed slightly in front of the person sitting at the table, but here again it is liable to catch one's eyes if not placed close to the ceiling. An occasional glimpse at the light would not seriously affect the eyes of the person at the table, but, again, every person's eyes are not the same, some being more easily affected than others. To relieve the eye strain as much as possible a glass shade should be used. It should be opal inside and green outside. The effect upon the eyes will be greatly relieved.

A frosted lamp may not be entirely satisfactory when tried. Here, a clear lamp should be tried, but a sheet of drawing paper should be glued round the bottom of the shade, this entirely closing the lamp. In this case it may be found necessary to increase the candle-power of the lamp. However, if "Pen" will experiment upon the lines outlined above, I feel sure he will come to a satisfactory result without any expense at all.—"ASTATIC."

The Second Prize Winner's reply will be published in due course.

Nelson.—The price of electricity has been reduced by ½d. per unit for lighting and ¼d. per unit for power.

Fleetwood.—The electricity profits for the year were approximately £5,700. There is to be a further reduction of ½d. per unit, making a total reduction of 2d. per unit in six months.

Reviews of Books, &c.

[Books noticed in this column will be sent from ELECTRICITY *Office to any part of the world, for the published price, plus ten per cent. for postage (minimum 2d.) and orders will be appreciated.]*

TABLES AND UNITS FOR ENGINEERING STUDENTS. By C. A. Walker and W. S. Ibbetson. (Spon, 1s. net.)—This is a useful set of tables which will appeal to a very large number of engineering students, more particularly those who are interested in mechanical as distinct from electrical work. There are, however, pages which deal with electrical and magnetic units and international symbols, and they are arranged very conveniently so as to catch the eye of the reader without any delay or waste of time. We have no doubt that the book will meet with a ready sale.

"MECHANICAL WORLD" ELECTRICAL POCKET BOOK, 1923. 326 pp. and diary. (Emmott, 1s. 6d.).—New features in this edition include a section on measuring instruments, embracing, besides the more common instruments, oscillographs of the Duddell, Irwin hot-wire and electrostatic types. Plant, load and diversity factors also come in for treatment, while mention should also be made of the notes on the Transverter, a combined transformer and commutator, with rotating brushes for the conversion of A.C. to D.C. up to very high pressures, and to a new table on the properties of insulating materials. A good miniature text book.

"PRACTICAL ENGINEER" ELECTRICAL POCKET BOOK, 1923. 636 pp. and diary. (Froude and Hodder and Stoughton; cloth, 2s. 6d.; pluviusin, 3s.).—With this edition the publication passes from its founders under new direction and control. The usual features are retained and we note considerable additions to the traction section by the inclusion of notes on the application of electric power to railways. The wireless section has been rewritten and the chemical engineering section revised. Both the rectifier and welding sections have been amplified.

THE SIMPLE LATHE AND ITS ACCESSORIES. 152 pp. 171 figs. (Cassell, 1s. 6d.).—This is a companion volume to "Metal Turning Made Easy"—both being editions in the well-known Cassell "Work" series of handbooks. Whereas the book just referred to deals with *using* the lathe, the one under review describes small lathes and their accessories, and should, therefore, be read first. After an illustrated description of the various types of lathes, there is a chapter in which are given descriptions of many well-known lathes now on the market. The major portion of the publication, however, is devoted to tools, accessories and attachments, and anyone becoming engaged in lathe work cannot fail to find some points of value and instruction in these pages. For those more interested in wood turning lathes there is a chapter devoted to these, complete with illustrations and notes on the correct use of the various wood-working tools. Finally we would mention that a novice would find the final chapter on lathes speeds and feeds of value, as it shows clearly how to calculate these matters, but the question of actual speeds and feeds for different classes of work does not fall within the scope of this volume.

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Trade Notes.

List No. 11 dealing with wireless receiving sets has recently been issued by the **Plant and Supplies, Ltd.**, of 12-13, Henrietta St., London, W.C. 2. It should be of direct interest to all dealers in wireless goods.

From the **Electric Heating Co.**, of George Street, Croydon, comes a copy of the latest price list of domestic electric irons, kettles, etc., in which the company have built up a very fine trade. It can be recommended as a list which should be in the hands of every contractor and retailer.

A small 8-pp. catalogue of "Supreme Radio Apparatus" has been issued by **Messrs. Shenton and Co., Ltd.**, of 68-69, Shoe Lane, London, E.C. 4. It will be of interest to all dealers in radio supplies, and as such we recommend it to the notice of trade readers generally.

A price list of Vanwyk's overload switches has just been issued by **Mr. Frederick Pratt**, of 23, Queen Anne's Gate, London, S.W. 1. It gives illustrations and details of this useful apparatus, and will therefore prove of direct interest to quite a large number of installation contractors and readers generally.

Monthly trade list No. 90 has just been issued by the **Siemens and English Electric Lamp Co., Ltd.**, of 38-39, Upper Thames Street, London, E.C.4. It gives illustrations and prices of many standard lines, such as lamps, telephones, "Zed" fuses, batteries, shades, wires, cables and accessories, and should therefore be of direct interest to a large number of trade readers, to whom it will be sent on receipt of proper business application.

Supplement Sheet No. 42 has just been issued by the **Consolidated Pneumatic Tool Co., Ltd.**, of 170, Piccadilly, London, W.1. It gives full details of the latest types of Little Giant grinders and polishers, as well as illustrations showing the practical applications to which these useful electric tools can be adapted. It should be of interest to all installation engineers, factory managers, shipyard foremen, etc.

Our clients the **Metropolitan Vickers Electrical Co., Ltd.**, of Trafford Park, Manchester, are preparing a new campaign in Cosmos fans. A novel booklet is to be printed for use by trade dealers, and enterprising readers who are interested in this particularly helpful proposition should make a point of writing at once to the company asking for an advance copy of booklet Y 4140/2 to be sent as soon as ready.

Booklet No. 980, which has just been issued by the **Simplex Conduits Co., Ltd.**, of Garrison Lane, Birmingham, gives illustrations, details and prices of the company's well-known "triple purpose" electric signs, which have proved so remarkably efficient for advertising, illuminating and decorating purposes. The booklet conveys a fairly complete impression of the ability of the company to produce any description of electrical illuminating sign, and special designs can, of course, be prepared according to the ideas of the client. It should therefore prove of direct interest and value to all electrical installation contractors who are anxious to push work with their clients throughout the country, and we advise early application for same from the trade.

From **Todman, Ryall and Co., Ltd.**, of 38, Grosvenor Gardens, London, S.W.1, comes a copy of their current stock sheet for D.C. motors and dynamos of their "LW" type. For this particular stock only they are in a position to accept remarkably low prices, thus giving an exceptional opportunity to those who have, or anticipate, a demand for any particular machines on the list. If any trade buyer has not already a copy of the catalogue, they will be pleased to send it on receipt of a post card.

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Various Items.

Meetings.—There will be a Wireless Section meeting of the I.E.E. on Wednesday, June 6, at 6 p.m. Paper: "Wireless Direction-finding in Steel Ships," by C. E. Horton.

Mid-Lancashire.—The Electricity Commissioners have issued their decisions in regard to this district, and will in due course prepare a draft order giving effect thereto, after which a further local inquiry will be held in accordance with the 1919 Electricity Supply Act.

Electric Vehicles.—The interest in this important branch of our industry continues to grow steadily, and readers who wish to be in touch with it should make a point of studying "The Electric Vehicle Handbook," by Cushing, which is the standard manual on the subject. The price is 10s. 6d. net post free from ELECTRICITY Office.

Removal.—Smith and Ansell, Ltd., manufacturers of electric light fittings and architectural metal work, are removing to larger premises, and on and after Wednesday, 23rd inst., their address will be Stockfield Works, Stockfield Road, Acocks Green, Birmingham. Telephone number, Acocks Green 269. Telegraphic address, Essalite, Birmingham.

Good Contracts.—The London County Council have renewed their contract with Siemens and English Electric Lamp Co., Ltd., for the supply of the whole of their requirements in electric incandescent lamps, including gasfilled, vacuum type and carbon filament lamps, for a further period of twelve months. The company have also secured a contract from the Port of London Authority for the supply of Siemens gasfilled type lamps.

D.P. Batteries.—That a public school should be equipped with an up-to-date electrical plant goes without saying, and the D.P. Battery Co., Ltd., Bakewell, have just installed one of their latest type storage batteries at Stowe House, near Buckingham, which has recently been converted from a country mansion to a public school. The D.P. battery was supplied through Messrs. Girdlestone and Co., who were responsible for the electrical work.

Germany.—The report on the economic and financial conditions in Germany to March, 1923, has just been issued by the Dept. of Overseas Trade, and may be obtained, price 4s. 3d. post free, from H.M. Stationery Office or from ELECTRICITY office. It is a comprehensive work of 158 pp., and contains matter which will interest English manufacturing firms who are in direct competition with importers of German electrical goods and machinery.

"**The Cost Accountant.**"—The official journal of the Institute of Cost and Works Accountants will commence its third volume with the June number, which will be published on June 5. The subscription has been reduced to members and registered students of the Institute as follows:—Members, 12s. per annum; registered students, 9s. per annum; hon. members, 18s. per annum. Single copies can be obtained from the Editorial Office, 38, Grosvenor Gardens, S.W.1, price 1s. 7d. per copy post free.

Meetings.—The annual general meeting of the I.E.E. will be held on Thursday, 31st inst., at 6 p.m., at the Institution Building, Savoy Place, Victoria Embankment, W.C. 2. At the beginning of the meeting there will be presented to the Institution:—(*a*) An oil painting of the late Dr. Silvanus Thompson, F.R.S. (presented by Mrs. Thompson); (*b*) Dr. Thompson's library (presented by a number of members of the Institution and others); (*c*) a bronze bust of Dr. Thompson, by Mr. Gilbert Bayes, A.R.A. (presented by the Finsbury Technical College Old Students' Association). The annual conversazione will be held on Thursday, June 28, 8.30 to 11 p.m., at the Natural History Museum, South Kensington, S.W.

"**Memoranda of Workshop Practice.**"—The three sections of this book by Mr. W. Glennie, the assistant general secretary of the A.E.U., have already been reviewed in these columns, and their practical value is so well known that further praise is superfluous; but we have much pleasure in informing our readers that the three separate volumes—viz., Part I., "Turning"; Part II., "Fitting"; and Part III., "Mechanical Drawing and Machine Construction"—may now be obtained combined in one complete volume, price 5s. 3d. post free, from Messrs. S. Rentell and Co., Ltd., 36, Maiden Lane, London, W.C.2. We can most certainly recommend it to any reader who has not yet purchased the work in separate sections.

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A POPULAR SCIENTIFIC WEEKLY JOURNAL
ELECTRICITY
A PRACTICAL TRADE JOURNAL

JUNE 1, 1923.

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THE E.M.F. AND P.D. OF SOME SPECIAL CELLS.

The terms "electromotive force" and "potential difference" require a word of explanation, as sometimes confusion of thought exists regarding them. The former denotes that which sets up and maintains the force driving the current in a circuit, and is, in the case of cells, derived from chemical action. The potential difference is the pressure, as read by a voltmeter, available at the terminals for the outside circuit, and is, generally speaking, less than the electromotive force.

Let us consider the relation existing between these two terms. Suppose that a cell is on open circuit, the pressure at the terminals will be numerically equal to the total pressure generated, that is, the terminal pressure equals the voltage of the cell. Again, if the terminals be connected by a short and thick copper wire, i.e., of no resistance, the whole of the e.m.f. will be employed in driving the current through the cell itself, the effect being almost the same as on short circuit.

Let the outside circuit now have a low but appreciable resistance, there will be fall of pressure in it, determined by the product of the current flowing and its resistance; with the usual notation this will be CR volts., while the fall of pressure, or lost volts, in the cell will be CR_1, where R_1 is the internal resistance of the cell. Calling E the e.m.f. of the cell, we thus have the relation that:—

Terminal Pressure = e.m.f. —Lost volts in the cell.
or P. D. = $E - CR_1$

Usually the resistance of the external circuit is large compared with that of the internal circuit, and the lost volts will be small, and the P.D. large.

Clearly, therefore, cells should be:—

(1) Not too small in size.
(2) Plates should be large, of good conductivity, and near each other.
(3) The exciting liquid should be a good conductor.

These governing principles, when carried out, should give a cell of high efficiency.

The following cells are special ones, inasmuch as they are not of the usual zinc-copper-acid type.

Alkaline Cell.—Excitant—Caustic potash or soda.
Depolariser—Oxide of copper.
Plates—Zinc and iron or copper.

The theory of action is that in the presence of a strong base (potash or soda), a weak base (zinc oxide) behaves as an acid, and a salt is gradually formed in the cell, in this case potassium or sodium zincate. The hydrogen set free in the first reaction is oxidised by the cupric oxide, as represented by the following equations:—

$$Zn + 2KOH = K_2ZnO_2 + 2H.$$
$$Zn + 2NaOH = Na_2ZnO_2 + 2H.$$
and
$$CuO + 2H = H_2O + Cu.$$

On the ground of economy, it is of note that potash is more costly than soda, but both labour under the disadvantage that they absorb carbonic acid gas from the air, with the production of the alkaline carbonate. This can be overcome by having the excitant covered with paraffin oil.

The e.m.f. is low, only about .7 volt, but its resistance is also very low, so that there is not much loss of voltage in the cell. Further, there is hardly any local action on open circuit.

Examples of such cells are:—

(i.) The Lalande—Chaperon cell.
(ii.) The Edison—Lalande cell.
(iii.) The Gordon cell.

They are of fairly liberal dimensions, $8\frac{1}{2}$ in. by $5\frac{1}{4}$ in., and furnish 3 amperes for 50 hours at .7 volt with one charge of excitant and depolariser. The first-named is made by dissolving $1\frac{1}{2}$ lb. of soda in 8 lb. of water.

Lead oxide cells.—The oxides of lead are:—Litharge PbO, red-lead Pb_3O_4, and lead peroxide PbO_2. The last is richest in oxygen and, moreover, readily parts with some of it, and is therefore the best depolariser. That it contains most oxygen is seen by converting the formulæ so as to have the same number of atoms of lead, thus:—

$$PbO = Pb_3O_3$$
$$Pb_3O_4 = Pb_3O_4$$
$$PbO_2 = Pb_3O_6$$

The e.m.f. of such cells is high, about $2\frac{1}{2}$ volts, but there is a tendency for insoluble sulphate of lead to be formed; this increases the internal resistance, and more voltage is lost in this than in the alkaline/copper oxide cell.

The lead peroxide is prepared electrolytically and is compressed round a core of lead, while the zinc has to be well amalgamated. The reactions expressing the chemical actions are:—

$$Zn + H_2SO_4 = ZnSO_4 + 2H$$
$$PbO_2 + H_2SO_4 + 2H = PbSO_4 + 2H_2O.$$

It is a point of some importance that the sulphuric acid should be of the right specific gravity, about 1.2, otherwise the basic sulphate ($PbO, PbSO_4$) may develop.

Mercury and Silver Chloride cells.—The formulæ for these salts are Hg_2Cl_2, mercurous chloride; $HgCl_2$, mercuric chloride; and $AgCl_1$ silver chloride; but of the two mercury salts only the first is used as a depolariser. They are costly and, especially the mercury salts, poisonous, but are good depolarising agents, and are in use especially with the Leclanche (Zn/Cu and ammonium chloride) type.

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They depend for their action on the fact that the hypothetical group ammonium (NH_4) is set free for an instant, but is at once converted into its chloride, thus keeping the excitant at its proper strength, thus:—

$$Zn + 2(NH_4)Cl = ZnCl_2 + 2NH_4$$
$$\text{and } 2(NH_4) + Hg_2Cl_2 = 2(NH_4)Cl + 2Hg.$$

The voltage is fairly high—1.45 volts—and does not fall much unless excessive currents are used.

With the silver chloride depolariser, the excitant may be the chloride of ammonium, zinc or sodium, and the voltage is about one.

The reactions are similar in nature to the foregoing, the silver salt readily parting with the chlorine, thus:—

$$Zn + 2(NH_4)Cl = ZnCl_2 + 2(NH_4).$$
$$2(NH_4 + 2AgCl = 2(NH_4)Cl + 2Ag$$

It loses voltage on standing, and is open to the same objection as the mercury salt, viz., excessive cost.

Standard cells.—These are cells whose e.m.f.'s are steady and are employed for comparing the voltage of other cells and not for furnishing current.

The chief standard cells are:—

Clark cell—Plates: Zn, Mercury.
Excitant: Zinc sulphate solution.
Depolariser: Mercurous and zinc sulphates.

The voltage is 1.434.

Weston cell.—Plates: Cadmium, Mercury.
Excitant: Cadmium sulphate solution.
Depolariser: Mercurous sulphate.

The voltage is 1.0184 and its internal resistance is 900 ohms.

INDUSTRIAL HYGIENE AND THE PREVENTION OF ACCIDENTS.

In a paper on the above subject read before the Royal Society of Arts on May 16, Mr. L. Gaster discussed in some detail the causes of industrial accidents, pointing out that in many cases inadequate lighting was responsible. In the year 1920 there were 1,404 fatal and 137,298 non-fatal accidents, involving a payment of nearly £6,000,000 under the Workmen's Compensation Act—quite apart from minor unreported accidents. There was no doubt that many of these accidents might be traced to inadequate lighting, as had been done, for example, in the case of accidents arising from "persons falling."

Mr. Gaster suggested that damage to material and spoiled work should also be grouped with accidents to persons as arising very frequently from "industrial fatigue," which was itself liable to be caused by inadequate lighting. In particular, if the illumination was not satisfactory, workers lacked that feeling of confidence which is necessary to accurate and efficient work. A variety of statistics were quoted in support of the contention that poor lighting is a handicap to the worker and acts as a restriction on output. Thus, in the sweet-packing industry, better lighting had resulted in an improved output of 10 per cent.; experiments in a coal mine had recently shown that a group of workers using a lamp giving four times the ordinary light produced 14 per cent. more coal than adjacent groups who had only the ordinary pattern of miner's lamp. In the cotton, fine linen weaving and silk industries, it had been shown, through the investigations of the Industrial Fatigue Research Board, that the average output was 5—12 per cent. higher by daylight than artificial light.

Reference was next made to the great advances that have been made in the measurement of light and the application of photometry to the study of daylight conditions during recent years, after which Mr. Gaster proceeded to give a summary of the main conclusions in the three reports of the Home Office Departmental Committee on Lighting in Factories and Workshops, pointing out that these very moderate requirements could be easily complied with, and were made in the interests of employers and workers alike.

The paper was illustrated by a considerable number of lantern slides, showing lighting conditions in modern factories, those dealing with the extensive repair shops of the London General Omnibus Co. by daylight and artificial light being particularly striking.

The chairman (Sir Malcolm Delevingne, Asst. Under-Secretary of State, Home Office) expressed his complete sympathy with the aims of the paper, and mentioned that the recommendations of the Home Office Departmental Committee would receive due attention in the next Factory Act. Miss R. E. Squire (Home Office, Factory Dept.) and others who spoke all expressed their appreciation of the importance of good industrial lighting, and after Mr. Gaster had briefly replied to the discussion, he was accorded a very hearty vote of thanks for his lecture.

A.C. NEUTRAL POINT EARTHING.

By S. Austen Stigant, A.M.I.E.E., M.Am.I.E.E., Member J.Inst.E.*

(*Concluded from page 276.*)

The earth connection.—While from time to time various isolated papers have been written dealing in general terms with the question of neutral point earthing, very little appears to have been published concerning the earth connection itself, that is, the apparatus buried in the earth (or otherwise located) for the purpose of obtaining a point at or near the potential of the earth. If the earthing system itself be not carefully considered, installed and maintained, it may, under fault conditions, be a distinct danger to human life.

The apparatus used for obtaining a direct earth contact may consist of copper or cast-iron plates, iron pipes of small or large diameters, or perforated metal cones. In generating stations where an ample supply of water is available, such, for instance, as for condensing purposes, the earth connection is frequently taken to the condenser pipe work, sometimes in addition to other apparatus and sometimes alone.

It is not always appreciated that it is very difficult to obtain resistance values of less than about 2 ohms from a single earth plate or other piece of apparatus, and often it is still more difficult to maintain the ohmic value after the earthing system has been installed for some time. On account of this it is usual to install several earth plates, pipes, etc., in parallel so that the combined resistance of the installation is reduced to a reasonably low value which may be of the order of quarter to half an ohm.

* Paper read before the Junior Institution of Engineers.

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The chief points to be borne in mind when laying down an earthing equipment are that the installation must possess sufficient total cross section to carry the maximum fault current, and it must have a very low resistance in order to keep down to a safe value the potential gradient in the earth surrounding the plates, etc., under fault conditions. As most of the resistance of the earthing system exists in the immediate vicinity of the plates, etc., the potential gradient in the earth under fault conditions is naturally similarly located, and in order that this shall be kept to such a value as will not endanger life, the current density in the earth installation should be kept to a low figure either by using a number of the plates, pipes, etc., in parallel, or else by burying the devices to a considerable depth, making the connection down to them by means of insulated cable. The former arrangement is one which can best be adopted where there are facilities for obtaining good earths, but in cases where, on account of the nature of the ground, it has been difficult to obtain a good earth, special plates or pipes have been sunk to a depth of between 30 and 50 feet. If the earthing apparatus can be buried in the bed of a river almost ideal conditions are obtained, but where this is not possible the apparatus should be buried in a prepared coke bed so as to retain water as much as possible. In such cases the installation is kept well watered, while the addition of salt very largely increases its conductivity.

Earth plates are usually made of galvanised cast-iron or copper, varying from 3 ft. to 6 ft. square, and from thicknesses of $\frac{1}{4}$ in. to $\frac{1}{2}$ in. Earth pipes are usually made of wrought-iron, and of lengths between 4 ft. and 6 ft., but the diameters, however, vary considerably.

It is most important that the connections from the neutral or auxiliary apparatus to the earth installation itself shall be of ample cross section, so that there is adequate margin over the maximum fault current, and so that no abnormal pressure drop occurs over their length. The connections to the earthing structure should be of ample surface contact, and they should be permanently brazed.

Generators in Parallel.—When a number of generators are operating in parallel on the same station busbars, the neutral points of all of them may be earthed, or one only may be earthed according to the characteristics of the individual machines and to the operating conditions. In some cases the generator neutral points are solidly connected together to a common earth bar, and a current limiting device is inserted between the earth bar and earth. In other cases the neutral points are all tied to a common neutral bar, but a resistance or reactance coil is inserted between *each* generator neutral point and the common neutral bar, while the bar itself may be connected to earth either direct or through a current limiting device. In other cases each generator is provided with its own neutral earthing resistance or other device, so arranged that one machine only is earthed at a time.

The advantage of simultaneously earthing the neutrals of all generators operating in parallel on the same busbars is that multiple earth paths are provided for the flow of fault current, and consequently the current limiting devices may have higher ohmic values, and, therefore, are cheap. On the other hand, if the generator neutrals are solidly coupled and one or more happen to be out of commission, it is possible to obtain pressure on those out of commission via the neutral connection should a feeder or generator fault occur. This would probably only be dangerous if repairs on one or more of the generators out of commission were being effected at the time, though the provision of an isolator in each generator neutral connection would effectively remove this hazard. A further disadvantage of coupling the neutrals of generators running in parallel is that the third harmonic characteristics of the various generators may be quite different, and depending upon the loading of the individual machines there may be probable third harmonic currents circulating between the various machines, and such currents may cause overheating. If, however, the neutral point of one running machine only is earthed at a time, no such effect can occur, but the earthing resistance must have lower ohmic value, so as to handle the entire fault current corresponding to the heaviest feeder relay setting.

Multiple Earthing.—In Great Britain the Board of Trade prohibits the earthing at more than one point of extra high pressure systems, that is, it is not possible to earth two points on the same system which are more or less widely apart. Regulations 18 and 19 of the Extra High Pressure Regulations reads:—

"18. Where any extra high pressure circuit is connected with earth, the connections shall be made at one point only—namely, at the generating station, substation or transformer—and the insulation of the circuit shall, except at that point, be efficiently maintained throughout.

"19. The neutral point of the star winding of each distinct three-phase circuit used for extra high pressure may be connected with earth, or may be insulated. If connected with earth through a resistance, that resistance shall be sufficiently low to ensure that the fuse or automatic circuit breaker in the mains shall act.

"If the neutral point is not connected with earth, a separate electrostatic voltmeter placed in a conspicuous position in the generating station shall be connected between each distinct circuit and earth; and, if the indications of the voltmeters show that the insulation of any of the circuits is faulty, immediate steps shall be taken to restore the insulation."

The idea underlying these regulations is the avoidance of the continual flow of leakage harmonic currents through the earth which might cause telephone interference, as the provision of more than one neutral point earth on a system provides one or more short circuit paths for the flow of third harmonic current and for currents having frequencies which are odd multiples of the third harmonic.

As a result of the experience gained in the U.S.A. from the operation of extensive high voltage power systems employing multiple earthing, it is the considered opinion of many responsible engineers in Great Britain that the restrictions imposed by the Board of Trade Regulation referred to are unnecessary and should be removed. On interconnected systems, where a number of generating stations situated some distance apart are running in parallel, a serious fault may leave the system temporarily insulated, and, while each generating station will doubtless be equipped for neutral point earthing should the necessity arise, the protection afforded by the earthed neutral is really temporarily withdrawn when it is most required. While such an occurrence is inclined to be infrequent, it has been

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known to occur. If multiple earthing were adopted *thoroughly*, the relatively large number of parallel paths available for the flow of harmonic currents would doubtless cause no real telephone disturbances on account of the diffusion and consequent weakening of harmonic current in the distributed paths.

Questions and Answers by Practical Men.

RULES.

QUESTIONS: *We invite our readers to send us questions, preferably on technical problems that have arisen in actual practice. Questions which we consider of sufficient interest to our readers will either be replied to under "Answers to Correspondents" or replies will be invited from our readers. One shilling will be paid for the question which we select for competitive replies in this column.*

ANSWERS: *A fee of 10s. will be paid for the answer which we consider shows the greatest merit, and 5s. for the one we select as second best. In judging the replies, importance will be attached to clearness and conciseness, as well as accuracy. The Editor reserves the right to make no award, or to accept only one reply, if, in his opinion, the answers received do not possess sufficient merit. Competitors desiring the return of their manuscripts, if unaccepted, should enclose stamped addressed envelope.*

Write on one side of the paper only, and if diagrams are sent, draw them on a separate sheet of paper attached to the manuscript. Competitors may adopt a "nom de plume," but, both in the case of questions and answers, the competitor's real name and address must be sent with the manuscript as a guarantee of good faith. No correspondence will be entered into with regard to successful replies. The Editor's decision is final.

Commencing with Question No. 101, a Diploma of Merit will be awarded to the six competitors who win the first or second prize the most times during the next twelve months.

The words "Questions and Answers" or "Q" and "A" should be placed at the top left-hand corner of all letters intended for this column.

QUESTION No. 161.

Are there any hard and fast rules for the earthing of motors? The other day one of my motors, 10 b.h.p., 440 volts D.C. 3-wire, developed an earth. To my surprise, the earth wire, connected from the motor to the conduit, fused. This wire was about $\frac{1}{8}$ in. copper. As this was evidently not strong enough, what wire should be used?—"EXAMINER."

QUESTION No. 162.

Can any reader give me details of the facts which govern the choice of high-tension insulators? I have heard talk of "Corona effect." What is this? Does it affect insulators used on voltages of over or under 6,600 volts?—"JOINTER."

(*Replies to Questions Nos. 161 and 162 must be received not later than June 30, 1923.*

Answers to Questions.

QUESTION No. 156.

The second prize (5s.) has been awarded to "L. R." for the following reply:—

It does not necessarily follow that because unshaded or incorrectly shaded lamps have been used in a drawing office that it is the proper course to turn directly to lighting solely by reflection. There is a choice to be made between direct and semi-indirect lighting, between general, local or localised general lighting, and between large and small units. Avoidance of glare is one of the most important factors to bear in mind. In the case of a small room possibly one unit will suffice for general lighting and for the provision of the main part of the illumination, but, in addition, a small local desk light may assist materially. It is now thought that lighting entirely by indirect means with an opaque reflector below a high-power source of illumination is both inartistic and, in a sense, inefficient because of the great contrast between the base of the reflector, which appears practically as a black spot, and the remainder of the room. Probably the more modern method of semi-indirect lighting is the best scheme to adopt, but in all cases the quantity of illumination per unit area must be sufficiently high. With indirect and semi-direct lighting, fault can often be found because the size of the units or the number of units is not sufficient to give the requisite illumination.

In the case of a drawing office the density of lighting should not be less than five foot-candles, and this entails a consumption of not less than one watt per square foot under average conditions. Half-watt lamps when used for direct lighting give a specific consumption in watts per lumen on the working plane of about 0.15 to 0.25, that is, watts per foot-candle per square foot illuminated. With the semi-indirect scheme, with the lamp contained in a deep opalescent reflector, the figure becomes 0.2 to 0.3, and with indirect lighting it is raised to 0.25 to 0.35.

A considerable variation in the amount of effective light obtained at the place required for a given consumption occurs according to the condition of the ceiling and the colour of the walls. If the figure for very dark ceiling and very dark walls be taken as a standard so that nothing has to be added over the calculated figure for giving the illumination obtained, for a very light ceiling and very light walls 30 per cent. increased illumination would be secured, and for a very light ceiling and very light walls there would be 80 per cent. added illumination.

The intrinsic brilliancy of different sources of light causes strain of varying amounts to be felt when working with artificial illuminants. In the case of a $\frac{1}{2}$-watt or other high candle-power incandescent lamp surrounded by light white glass hemispheres, the candle-power per square inch varies from 1 to 5, whereas with an incandescent lamp shaded by a dense opal globe it more closely approaches .1 to .5. On the other hand, an unshaded $\frac{1}{2}$-watt lamp gives a very high intrinsic brilliancy somewhat of the order of 2,000 candle-power to the square inch. For purposes of comparison, the figure for a uniform white sky as far as one can average the matter may be taken as $2\frac{1}{2}$ candle-power per square inch.

The next point that must be considered is the avoidance of reflecting rays from the source of light directly into the eye. This is especially important when one is working with the glossy side of tracing cloth. By sloping the tracing board to a convenient angle, which can be ascertained by trial having regard to the position of the light, the direct reflection can be transferred to some direction not directly entering the eye.

If an adequate quantity of illumination be provided by means of an indirect fitting as suggested, additional desk units ought not to be required, but if for special work it is necessary to add them, then it will be found that the large general illumination will tend to prevent eye-strain from the effect of the high local illumination, because the contrasts between the results of the two series of illuminations will not be unduly pronounced.

It only remains now to point out that strain in the eyes may not be entirely due to the illumination, but may, at least in part, be due to defects in the eyes themselves.—"L. R."

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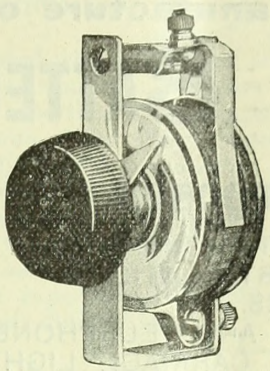
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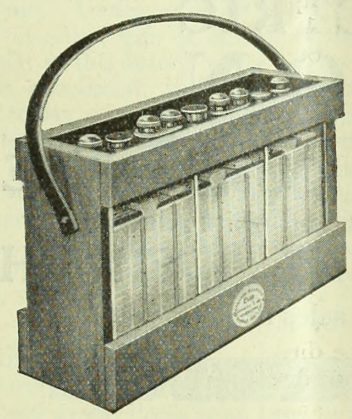
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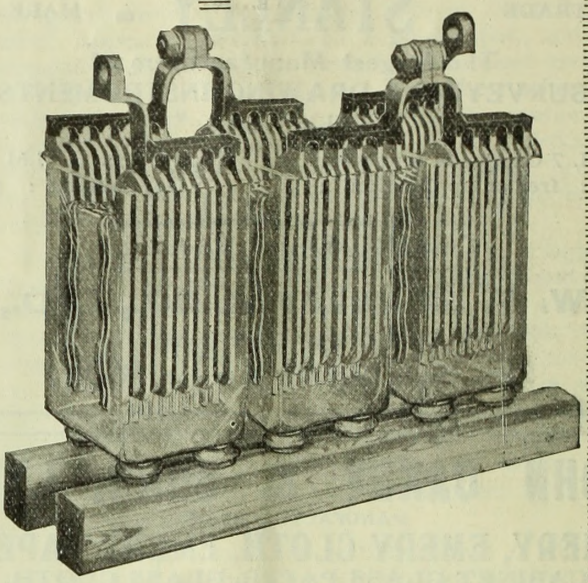
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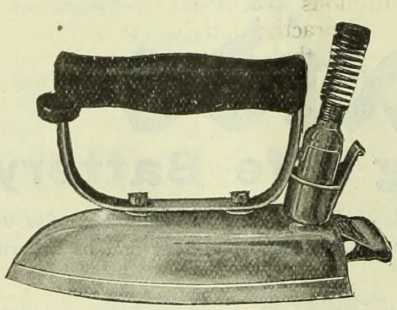
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WRITE TO-DAY FOR LIST OF DOMESTIC APPLIANCES

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Current Topics.

Fittings and Compulsory Inspection.

Arising doubtless from the recent epidemic of gas fatalities, the London County Council have expressed the view that gas companies and municipal gas undertakings should be given additional powers as regards the inspection of piping and appliances which were placed in a consumer's house, and should also be empowered to refuse to give or to continue to give a supply of gas under certain circumstances. The Public Control Committee was strongly of the opinion that a careful supervision in these respects would do much to obviate danger from leakage, and should secure that consumers used gas with a maximum of efficiency. If approved by the Board of Trade, effect might be given to the suggestion by the insertion in future gas enactments of a model clause dealing with the subject.

What is sauce for the goose is sauce for the gander, and it may be that if the suggestion is adopted, at some future date similar powers will be sought to conduct periodical inspections of the wiring and appliances in regular use by electricity consumers. Although the risk in the latter case is not so great, there is undoubtedly something to be said in favour of such a scheme. Under existing conditions, once an installation of either gas or electricity has been inspected and passed at the outset by an officer of the supply department concerned, it is regarded as safe for all time, regardless of the obvious fact that gas itself corrodes fittings, piping decays, taps lose their "off" stop pins, and in the case of electric light and other fittings, plaster disintegrates and allows them to come loose, switches wear out, flexibles become frayed, and, in short, everything connected with such installations is subject to the ordinary ravages caused by wear and tear.

Coupled with this natural decay, we have the all too numerous cases of shoddy material and workmanship exposed in the Press from time to time, and due largely to the installation of inferior fittings and materials and the craze for ultra cheapness. Every mishap, either in a gas or electrically-equipped house, which is directly traceable to such causes as defective fittings, fused wires, and the like, contributes to the disrepute of both industries, and from the standpoint of both the trade and the supply undertakings we ought to welcome the suggestion. It is, perhaps, rough luck on a tenant to have his gas pipes and fittings condemned as unsafe, or his electric light switches and wiring reported unfit for further service, but the alternative menace to his future health and safety makes it well worth while, and such a policy would tend ultimately to weed out scamped and inferior workmanship and materials.

Railway Electrification.

A good case was made out for the further electrification of suburban lines, at all events, by Sir Philip Dawson, M.P., in a recent address to the members of the Institute of Transport. His conclusions were arrived at upon actual results achieved with steam, and on the results and experience derived from over ten years' operation of electric trains over a portion of the Brighton section of the Southern Railway. Sir Philip stated that there had been a steady rise in the number of passengers carried electrically, while over a like comparative period the gross and net receipts in the case of steam had been falling, and in the case of the electric services they were still increasing. In the case of steam, on the other hand, expenditure was still on the up grade and gross receipts diminishing.

In the subsequent discussion, Sir Philip Nash referred to the address as illustrating the success which attended the electrifying of a railway for suburban purposes. There were many instances in this country where the suburban traffic was reaching a point which was getting beyond the capacity of steam, and the way of escape lay with electrification. It was further stated that a scheme had been prepared for the electrification of eighty miles of railway between York and Newcastle, and 90 per cent. of the trains would be run at two speeds, 60 and 30 miles per hour respectively, as against the present five or six differing speeds, thus effecting an economy which could not be overestimated. With the actual electrification of eighty miles of continuous track in this country we are approaching the practicability of main line electrification, and no doubt the resultant operation of this new long-distance scheme will be watched with keen interest by electric traction engineers.

Tidal Power at Last?

According to report, an extensive hydro-electric scheme is projected for Mersea Island, which, if carried out in its entirety, will, it is anticipated, reduce the cost of electrical energy in Colchester and district, as well as demonstrate the possibility of harnessing the tides for the purpose of generating electrical energy. The scheme, which is stated to have been approved by the Electricity Commissioners, is of a very comprehensive character, and options have already been secured for all the acreage required in order to provide a huge tidal lake, which will be fed by the sea and equipped with a receiving and retaining basin for the period of high tides. The Mersea Island installation, if it materialises, will be the first in Great Britain to utilise the tides for this purpose.

Broadcasting.

When is officialdom going to straighten out the tangle and lend its aid to reviving the now moribund trade and pastime? Although we are entering upon the summer months, in spite of the weather, there is no fundamental reason why listening-in should not be as popular now as during the darker winter evenings. There is just as much enjoyment to be derived from the new hobby out of doors on a fine

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summer evening as inside the house, but the whole problem is up to the powers that be. We are told that a Special Committee, appointed by the Postmaster-General, has been sitting to consider all the questions at stake and to make recommendations. Surely it has had plenty of time to deliberate over what are after all comparatively simple problems. The issue of the long-promised third licence, and the terms accompanying it, have been awaited for so long that many intending participants are losing interest, and the trade in both complete sets and components is languishing for lack of interest and support.

Coupled with this we have the avowed hostility of the theatrical magnates, whose grievance is largely imaginary. It is extremely unlikely that the popularity and growth of the Broadcasting movement will make six-pennyworth of difference to box-office receipts in the long run. It might just as well be argued that the cinemas have killed the legitimate stage. The question of authors' copyright can readily be settled, and, in short, there is no really tangible obstacle to the continuance of broadcasting on the same popular scale with which it commenced. We have criticised the American movement, and referred in no very ingratiating terms to the chaos which is alleged to exist in the States, but it would appear that we are laying ourselves open to far more scathing comment on the part of our friends across the pond by our mishandling of this once popular pastime.

Industrial Lighting.

The Royal Society of Arts has made a practice of having papers reviewing progress in industrial lighting at intervals of a few years, and Mr. Gaster's address on this subject on May 16 contained ample proof of its importance. One of the chief objects of the paper was to make the contents of the reports of the Departmental Committee on Lighting in Factories and Workshops more widely known, and towards the end of his paper Mr. Gaster paid a well-deserved compliment to the Home Office for the judicious way in which they have handled this somewhat complex problem of industrial lighting.

It was interesting to hear from the chairman, Sir Malcolm Delevingne (Assistant Under-Secretary of State, Home Office) that the recommendations of the committee will be embodied in the next edition of the Factory Act. Lighting will thus take its place with heating and ventilation as an acknowledged necessity in the interests of health, safety and efficiency of work. I have no doubt that the adoption of these very moderate recommendations would be welcomed by employers and workers alike.

Wembley, 1924.

I have to thank the B.E.A.M.A. for an advance plan of the Electrical and Allied Engineering Section of the great British Empire Exhibition which is due to be held next year. It shows that a decidedly healthy amount of space has already been booked and provisionally reserved, and the white, or unlet, spaces make a very poor show. There is no doubt whatever that trade is now absolutely on the mend, and that fact should act as a direct incentive to enterprising manufacturers who have not booked space to do so at once before it is too late. I admit that the names already announced represent most of the big firms in our profession, but that it not enough. All must be there if they can get space. The exhibition as a whole is bound to bring a welcome increase of trade to this country, and it is up to us to take the utmost possible advantage of what is, after all, a magnificent Empire advertisement, the effect of which will be felt for long years afterwards. My worry is whether we shall be able to do justice to the marvellous collection of exhibits which we shall have to describe. At any rate, all in his power will be done by

ELEKTRON.

THE CLYDE VALLEY E.H.T. INTERCONNECTOR AND ITS PROTECTIVE SYSTEM.

One of the largest 33,000 volt cables at present installed in the British Isles is that on the Clyde Valley system, which is used as an interconnector between the Yoker and Clyde Mill power-stations.

This cable was constructed by the Pirelli-General Cable Works, Ltd.—one of the associated factories of the General Electric Co., Ltd.—Southampton. It is a three-core cable, each core being .2 sq. in. cross sectional area, round conductors, paper insulated, the three cores being laid up and made circular with impregnated paper fillings, covered by further belt of impregnated paper, lead sheathed, compounded jute served, double steel tape armoured and compounded jute served overall. The cable is built for a working voltage of 33,000, the centre point of the system being earthed, and is constructed in accordance with the following dimensions.

Thickness of insulation, copper to copper, .512 in.
Thickness of insulation, copper to lead, .354 in.
Thickness of lead sheath, .15 in.
Thickness of each steel tape, .06 in.
Overall diameter, 3.55 in.
Weight per mile, 38.5 tons.

The cable was manufactured in lengths of 200/220 yards, the total length of the line being 15½ miles.

The tests taken in the works, on each length during the lead cased stage, were as follows:—

1.—Insulation resistance measured with 400 volts D.C., after 24 hours' immersion in water. The average result obtained was 250 megohms per st/ml.

2.—Inductive capacity measured between one core and the other two and earth with 400 volts D.C. The average result was .29 microfarads per st/ml.

3.—Conductor resistance checked after 24 hours in water.

4.—Each drum of cable pressure tested with 66,000 volts for a quarter of an hour between cores, and 40,000 volts for a quarter of an hour between cores and lead.

5.—Bending test (made on a percentage of the drums). A three yards' sample of cable, bent three times in each direction to a radius equal to ten times the diameter of the cable. No sample so tested broke

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down at less than 120,000 volts between cores, or 80,000 volts between cores and lead.

6.—A dielectric loss test was made at voltages up to 50 per cent. above working pressure in all cases.

When the cable had reached the finished stage further tests were taken as a check: insulation resistance, inductive capacity, copper resistance, pressure test and dielectric loss.

In addition to the above tests, samples of the cable were subjected to special pressure tests as follows:—

Sample No. 1.—This sample was tested by applying and gradually raising the pressure between two cores until the testing ends flashed over. The voltage at which this occurred was 192,000 volts between cores. A similar test was made, between cores and sheath, up to a voltage of 120,000. The cable was not broken down.

Sample No. 2.—It was then desired to find out what would happen to this cable if it were run at a considerably higher voltage for a long period of time, and to this end a length was taken and subjected to a three-phase voltage of 100,000 volts between cores for a period of six hours. At the end of this time, although the cable had not broken down, the test was stopped and the cable dissected so that the paper on the conductors and fillings could be examined. It was found that in some places the paper was very slightly carbonised, which, of course, was to be expected.

Sample No. 3.—A further test was then decided on, and a sample of the cable was taken and subjected to a three-phase pressure of 60,000 volts between cores, which is close on double the normal working pressure, this voltage being maintained for 24 hours continuously. At the end of this time the cable was again opened out, and it was found that absolutely no carbonising of paper, either in the insulation of the cores or in the fillings, had taken place.

The particular features to be observed from the test results are that the cable itself has an exceedingly high breakdown voltage, and, further, that it will stand for a considerable time very great increases of pressure; but such increases are unlikely to be obtained in practice.

The G.E.C. Biased Differential Protective System, which we have described on other occasions, is used. The main feature is the use of a relay having a definite bias. The operation of the relay depends primarily upon an out-of-balance current being set up in the auxiliary relay circuit due to the obvious fact that more current flows into a feeder or other apparatus than flows out when a leak occurs. The current is produced in the relay circuit by means of current transformers at opposite ends of the feeder. The secondaries of these transformers are connected for circulating current and in series with the relays by means of pilot wires.

The novel part of the system is not so much in this general principle of operation, but in the bias of the relays, whereby consistent protection is given at all loads. Thus, if the bias is 10 per cent., the relay will operate when the leak amounts to 10 per cent. of the current flowing in the main circuit, whether this is normal load or overload. This biasing principle may be applied in a number of ways. For example, the relay itself may be biased, or the biasing may be secured by means of an ohmic resistance connected in the circuit, by varying the proportions of the current transformers at either end relatively to each other, or by other means.

Another advantage of the system is that the current is constantly circulating in the pilot wires, so that directly a break occurs in the pilot wire the relay

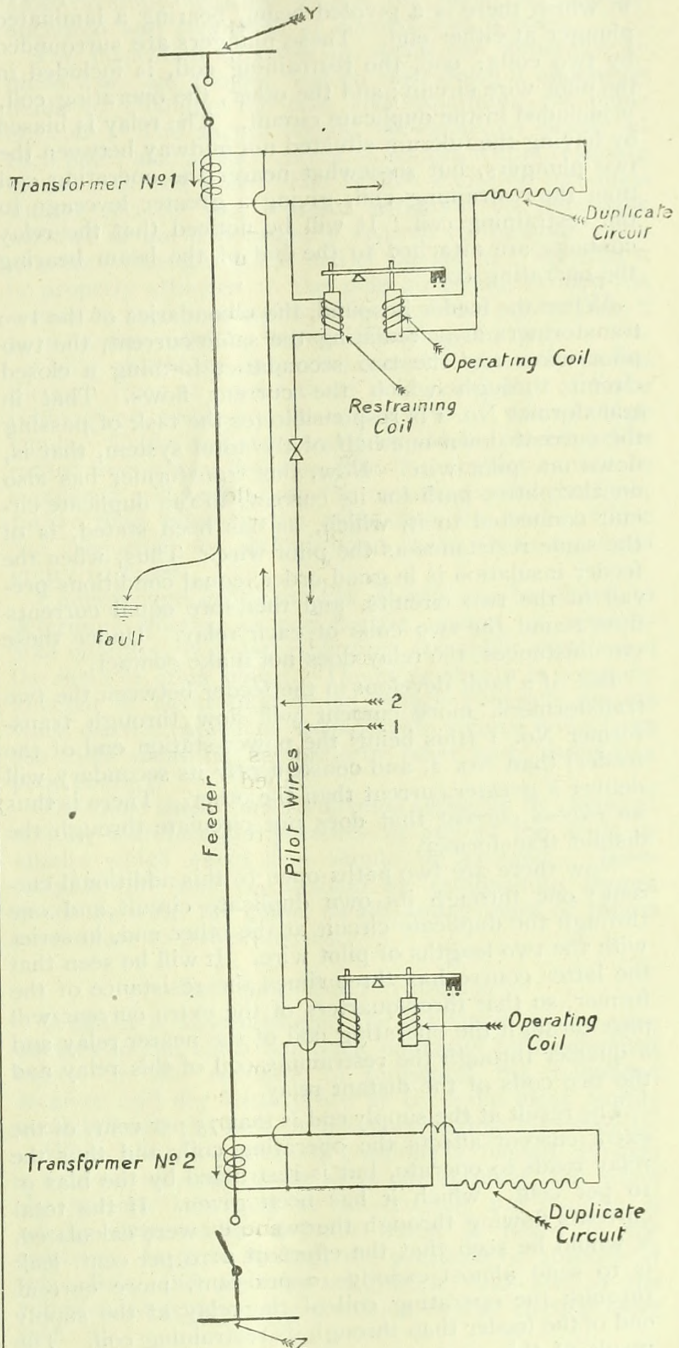


FIG. 1.—DIAGRAM OF CONNECTIONS OF G.E.C. BIASED SYSTEM OF PROTECTION (MCCOLL'S PATENT).

operates, if there is not less than 20 per cent. load current on the cable.

We are now in a position to study the application of the system to a single-phase feeder (see Fig. 1).

This diagram of connections shows the G.E.C. standard method of protecting feeders on the McColl

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system. Current transformers are located at each end of the feeder, and similar connections are made to the secondaries at either end. As will be seen, the leads from these windings branch, in each case one set going to the pilot wires and the other through a duplicate circuit, which is adjusted to have the same resistance as one of the pilot wires. Plunger relays are employed in which there is a pivoted beam, bearing a laminated plunger at either end. These plungers are surrounded by two coils: one, the restraining coil, is included in the pilot wire circuit; and the other, the operating coil, is included in the duplicate circuit. The relay is biased by having the fulcrum situated not midway between the two plungers, but somewhat nearer the operating coil than the restraining coil, giving a greater leverage to the restraining coil. It will be noticed that the relay contacts are attached to the end of the beam bearing the operating coil.

When the feeder is sound, the secondaries of the two transformers are circulating the same current, the two pilot wires and the two secondaries forming a closed circuit through which the current flows. That in transformer No. 1 is responsible for the task of passing the current down one half of the total system, that is, down one pilot wire. Now, this transformer has also an alternative path for its current, in the duplicate circuit connected to it, which, as has been stated, is of the same resistance as the pilot wire. Thus, when the feeder insulation is in good order, equal conditions prevail in the two circuits, and therefore equal currents flow round the two coils of each relay. Under these circumstances, the relay does not make contact.

But if a fault develops in the feeder between the two transformers, more current will flow through transformer No. 1 (this being the power-station end of the feeder) than No. 2, and consequently its secondary will deliver a greater current than the other. There is thus an excess current that does not circulate through the distant transformer.

Now there are two paths open to this additional current: one through its own duplicate circuit and one through the duplicate circuit at the other end, in series with the two lengths of pilot wire. It will be seen that the latter course has three times the resistance of the former, so that three-quarters of the extra current will pass through the operating coil of the nearer relay and a quarter through the restraining coil of this relay and the two coils of the distant relay.

The result at the supply end is that 75 per cent. of the extra current affects the operating coil, and thus the relay tends to operate, but is restrained by the bias of 10 per cent. which it has been given. If the total currents flowing through the two coils were calculated, it would be seen that the effect of a 10 per cent. leak is to send almost exactly 10 per cent. more current through the operating coil of the relay at the supply end of the feeder than through its restraining coil. The result of this 10 per cent. leak is, therefore, that the relay operates, completing the local circuit and tripping the circuit breaker.

The above holds good whatever the load on the feeder, as the relay deals in percentages only and operates when the excess current is 10 per cent. greater than the local current, whatever the value of the latter; this is secured, as will be remembered, by the additional leverage given to the restraining plunger. Thus, the load on the feeder can increase indefinitely without there being any risk of the relays tripping through a slight error in the balancing of the transformers, which, by the way, are of the ordinary standard series-connected type. It should also be mentioned that capacity current in the pilot wires produces no disturbing effect, as it flows through the restraining coils and actually increases the stability. In any case, the capacity current is small, since the current is a circulating one, and the voltage, which is low, falls progressively along the length of the pilot wires.

We will now consider the arrangement of apparatus applied to the Clyde Valley feeder. This inter-connector has an 18,000 k.v.a. 11,000/33,000 volt transformer bank at each end, as shown in the diagram of connections (Fig. 2). Likewise a 1,500 k.v.a. bank of booster

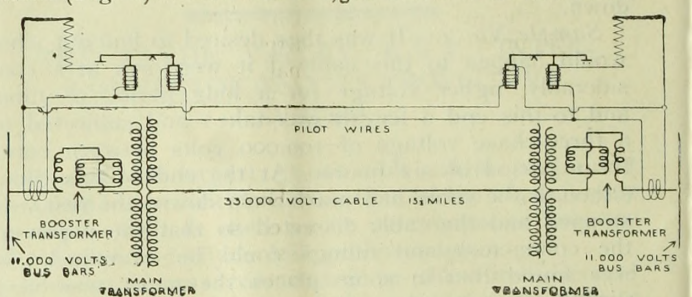


FIG. 2.—DIAGRAM SHOWING CONNECTIONS OF G.E.C. BIASED SYSTEM OF PROTECTION (McCOLL'S PATENT) APPLIED TO 30,000 VOLT FEEDER ON THE CLYDE VALLEY SYSTEM.

transformers is placed at each end to compensate for drop in line and inductive drop in the main transformers at low-power factors. The series transformers for the protective gear are connected in the 11,000-volt side at each end, and include within their protection the main transformer banks, booster banks and cable. The main transformer banks are 11,000 volt delta and 33,000 volt star, the neutral point of the 33,000-volt side being earthed solid on one bank and through a spark gap on the other bank.

(To be continued.)

THE POSTAGE STAMP.

MAKE IT CARRY ITS FULL LOAD

With the new postal regulations in force whereby 2 oz. of printed matter may be despatched for ½d., and 2 oz. may be enclosed in a sealed envelope to go at the minimum letter rate of 1½d., it is up to electricity suppliers and contractors to make the utmost use of the concessions by increased postal publicity—a form of publicity of the utmost value. In this connection, it is not out of place to remind electricity suppliers and contractors that the British Electrical Development Association has a very large number of envelope fillers among its wide range of general and specialised publicity matter, which can be used with advantage to the industry as a whole, and the sender in particular.

"Current" Humour.—"Some of the things said over the wires," said the girl at the long-distance board, to the lineman making repairs, "are not fit for me to hear." "Aw, g-wan," replied the lineman; "you can't expect to work around electricity and not get shocked."

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MAINTENANCE OF TELEPHONE CABLE.*

By Mark T. Caster,
Plant Superintendent, Lincoln Telephone and Telegraph Co., Lincoln, Neb.

Professor Alexander Graham Bell invented the telephone in 1876. He expressed the idea that cables of telephone wires could be laid underground or suspended overhead, communicating by branch wires with private dwellings, country houses, shops, manufacturers, etc., uniting them through the main cable with a central office where the wire could be connected as desired, thus establishing direct communication between any two places in the city.

During the development of the telephone industry the use of telephone cable has rapidly increased, until at present the amount invested in telephone cables represents approximately one-fourth the investment in distributing plant. Therefore, maintaining this part of the telephone plant warrants very careful attention and the application of the best means for reducing the expense and the service interruptions which result from cable troubles.

Cable trouble is like war, because in some ways it merits Sherman's definition of war, but more particularly because prevention is better than cure.

Because the conductors contained in the cable are generally insulated with paper, the insulating quality of which depends upon the absence of moisture, the importance of continuity of the sheath surrounding the cable is obvious.

Lead was selected for use in covering telephone cables because of its flexibility and because of its price. Pure lead, however, readily crystallises when subjected to vibration or frequent bending, and is ductile to a high degree. It has been found that the addition of a small percentage of tin or antimony produces an alloy which resists these phenomena and insures a reasonable length of life of cable sheath and protection for the lines carried through the cables.

As even the best obtainable cable sheath is susceptible to crystallisation and other damage due to vibration, bending and pressure, it is necessary that cable be properly supported so as to reduce vibration and bending to a minimum, and to exclude as far as possible any constant pressure upon the sheath in a concentrated area.

Approximately 90 per cent. of cable trouble can be foreseen and prevented. Visual inspections of the entire cable system above ground and in manholes should be made at regular periods in order to detect bad conditions and apply remedies which will avoid trouble later on. In general an inspection of cable in manholes, if made every two years, will be sufficient. Inspection of aerial cable should be made at least twice each year.

There are certain locations and conditions where faults are most likely to develop. In manholes these points are where the cable enters the duct, and where cable supports should be in the manhole. The lack of proper supports will result in cracked sheath near the end of splices.

In the inspection of aerial cable the inspector should examine the cable along the entire length of each riser not protected by moulding or pipe; examine closely the sheath at the top of the riser pipe or at the end of the moulding; inspect carefully all cleats and supports; and examine the sheath at the point where the riser cable leaves the pole and joins the cable on the messenger, giving careful attention to the cable supports near the pole and the condition of the sheath under and between these supports. Also he should note carefully whether or not the cable is properly anchored and supported at corners and splices.

The inspection of cable in spans can generally be made from the ground, but on riser poles it should be made by climbing the pole and examining the cable critically. The sheath should be examined closely at each pole; also at each end of all splices within reaching distance of the pole. The branch cable at terminals should receive very careful attention to determine whether or not it is properly secured to the main cable and the messenger at the end of the splice. See that it is properly attached to the pole so as not to rest on crossarm braces or other pole hardware; also that it is not being used by anyone climbing the pole.

Cable should be inspected closely where it passes through trees or where there is a possibility of limbs rubbing or coming in contact with it during high winds. Cable and messenger should be placed below rather than above limbs so that if a contact cannot be avoided it will be between the messenger and the limb, rather than between the cable and the limb. Cable can frequently be shifted upon poles so as to avoid injury to trees.

Underground cable sheaths should also be tested to determine whether or not electric current, of appreciable quantity, is passing between the cable sheath and the earth or other object. The cable sheath is seriously affected by electrolytic action, which generally results when electric current of considerable volume flows from the cable sheath to the earth or other body through a poor contact.

The cable sheath is also affected seriously by chemical action; therefore the presence of any of the acids or alkalis which affect lead should be avoided. Electrolysis can best be avoided by establishing proper bonds between the cable sheath and ground or return conductors to power houses.

Locating Cable Trouble.

When it is suspected that the insulation on the conductors in the cable has been damaged by mechanical injury or the entrance of moisture, the telephone receiver and dry battery are at once the most readily available and the best preliminary testing instruments.

When electric current is continually passed through a receiver no noise is heard in the receiver, but when the current is varied or interrupted the change is readily detected by a click which is heard in the receiver. In cable testing, the presence or absence of this click, and also its magnitude, indicate to the experienced testman the condition of any circuit under test.

The following arrangement is best for use in magneto exchanges:—

A wire should be connected from one pole of the receiver to ground and another piece of wire attached to the other pole of the receiver. This last wire can be used as a feeler for testing the conductors at the end of the cable and determining roughly the number of conductors in trouble. It will readily be noticed that, when a contact is first made and broken with a

* *Telephony*, Chicago.

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good conductor, a click similar to that produced by connecting the receiver across the terminals of a condenser is heard in the receiver. Subsequent contacts, however, with this same good conductor will not result in subsequent clicks being heard in the receiver.

This is due to the fact that the static electricity stored in the conductor causes a click when it is discharged to ground, and unless a considerable amount of time elapses before successive contacts are made, no additional click will be heard. However, if the insulation is impaired the conductor will not retain a static charge, hence no click will be heard when such a conductor is tested. By introducing the dry cell between the receiver and ground and touching the conductors with the test wire, a click will be produced in the receiver each time a conductor with impaired insulation is touched.

In common battery exchanges the use of the exchange switchboard signal can generally be used in determining which lines are in trouble. The receiver is also convenient in detecting whether or not idle conductors in the cable are affected.

To test cable in a common battery exchange, connect one terminal of the receiver to ground and, with a wire or clip attached to the other terminal, touch working pairs to find the battery side of a line. When battery is encountered, it will cause a sharp click in the receiver. If a light click is heard, the cable lug should be tapped two or three times to determine whether or not the click is caused by static discharge or battery current flow.

After determining which conductors are affected, a study of the cable distribution chart will sometimes reveal quickly what section of cable contains the fault. For example: If only conductors Nos. 21 to 35 test in trouble and there is a 15-inch branch which contains this count, the task is reduced to locating the fault in this section of cable.

The Wireless Test Set.

The wireless test set consists of an apparatus called a "fault finder," for producing an interrupted current; also of an exploring coil and a telephone receiver. The fault finder is made up of an induction coil, vibrator—sometimes also an interrupter—a battery consisting of from one to four dry cells, a two-point switch, and a set of binding posts. This apparatus is mounted in a compact wooden case. Diagrams of the wiring are usually shown on the lid of the case.

The exploring coil is very simple and rugged in construction. A simple coil of insulated wire is wound on a soft iron core, and the ends of the coil are terminated so that the cord tips of a head receiver may be attached thereto.

The Use of the Set.

The test set is designed for locating crosses, grounds, short circuits, split pairs and wet pairs in both underground and aerial cable systems. It cannot be used in locating opens. It must not be used in locating faults in loaded cables as it is liable to magnetise the loading coils.

Method of Operation.

The vibrator of the apparatus for producing the tone or interrupted current, used in connection with the exploring coil, should be adjusted to operate at as low a frequency as is consistent with a uniform tone.

When the battery switch is closed, the vibrator will operate continuously. The secondary of the induction coil is provided with two windings, "high" and "low." In the Matthews' set, terminals 4 and 5 are connected to the low wind.

In locating grounds, wet spots, short circuits and crossed or split pairs, the low winding should be used whenever possible. The proper winding to use can be determined in the following manner:—

Connect the conductor or conductors in trouble to either the high or low winding and then test for the tone with the exploring coil at some convenient point on the cable, noting the volume of tone in the receiver. After this has been done, connect the conductor or conductors in trouble to the other winding and note the volume of tone as in the first instance. The winding which gives the greater amount of tone in the receiver is the proper one to use in locating the fault in question.

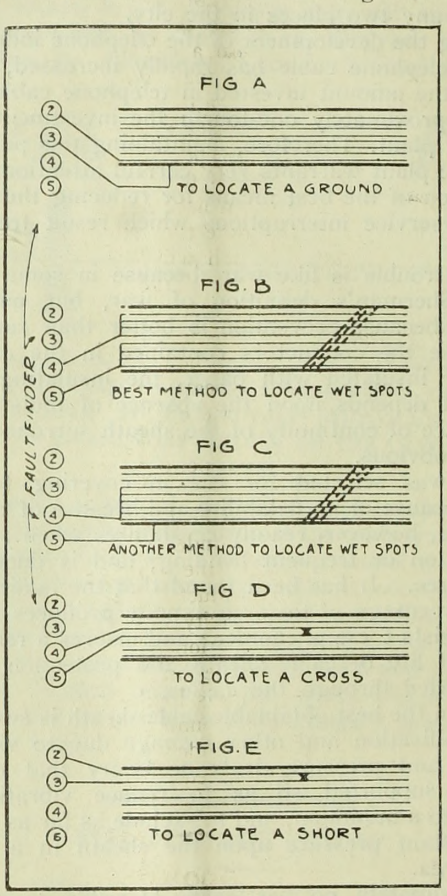


FIG. 1.—Method of Locating Cable Troubles.

Drawings in Fig. 1 show the correct connection to use for the various faults encountered.

Locating Grounds.

For locating grounds the test set should be connected as shown in Fig. 1-*A*. The exploring coil should be held on the under side of the cable in order to eliminate any effect from currents flowing in the messenger strand. However, in large cables, because the different layers of wires are placed spirally, the magnitude of the current induced in the exploring coil will vary at certain points along the cable.

Therefore, if the exploring coil is continually held on the lower side of large cables, there will be certain

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points located at regular intervals, not more than a few feet apart, where the tone is scarcely audible, and an equal number of points located midway between these where the tone will be comparatively louder. In such cases the exploring coil should be moved in a spiral manner around the cable sheath. This will avoid being misled by a vanishing tone when locating high resistance faults, or when the fault is a long distance from the point at which the interrupted current is applied

To save time and labour of riding every span while using the exploring coil, satisfactory results may be had by climbing poles at intervals along the cable route and making listening tests at these places until the trouble is located in a certain section or span. It is then necessary to complete the listening tests by riding that section or span in a cable car.

When locating high resistance grounds, the tone reduced in volume will be heard beyond the location of the fault. The only way that troubles of this nature can be located is by noting the point at which a noticeable decrease in the volume of tone occurs. In these cases it is desirable, and often necessary, that the fault finder be connected to the defective conductor or conductors at the terminal, which will leave the shortest possible length of conductor beyond the probable location of the fault, in order to reduce the capacity effect of the conductor beyond the fault to a minimum.

In case the exact location of the fault is not apparent from the condition of the sheath, it is necessary to connect the test set first to one end of the conductors and then to the other, thus checking one location against another before any opening is made in the sheath.

Cross-connecting boxes may be utilised as test points at which to connect the fault finder in order to shorten the distance between it and the fault. The cross-connecting jumpers of the conductors under test should be opened to reduce the capacity effect resulting from the conductors in the good section of cable.

This is especially desirable in cases where the moisture trouble is light, and is located in the section of cable between the cross-connecting box and the office. In starting the fault finder should be attached to the conductors at the office end.

(To be continued.)

Reviews of Books, &c.

[Books noticed in this column will be sent from ELECTRICITY *Office to any part of the world, for the published price, plus ten per cent. for postage (minimum 2d.) and orders will be appreciated.]*

INDUSTRIAL APPLICATION OF X-RAYS. By P. H. S. Kempton. 112 pp., 35 figs., 7 tables. (Pitman, 2s. 6d.).—Developments in the production and use of X-rays since their discovery by Röntgen in 1895 have been rapid—at first, more particularly in the medical field, but lately, in addition, in the field of "Radio-materiology," or the examination of materials by means of X-rays. The late war undoubtedly led to tremendous strides being made, so that now, in a large number of instances, it is by far the most satisfactory means, and in many cases the only means, of detecting flaws in metallic products, the uniformity of welded, brazed, soldered or other joins, the presence of foreign particles, etc., in electrical insulating material, etc. The method can be applied to finished composite parts, machines and structures, and can also be used to determine the composition of alloys and to detect fatigue. No better introduction to this important question could be wished for than that given in this excellent "Primer," which, besides explaining the uses to which X-rays can be put industrially, gives full details of the different types of rays, and of the developments of the apparatus necessary for different tests, their limitations and the necessary precautions to adopt. As is usual in books of this series, there is a concise bibliography included.

INTERNAL COMBUSTION ENGINES. By O'Kill, cr. 8vo, 126 pp., 27 illus. (Pitman, 3s.)—This is yet another of the "Common Commodities and Industries" series, which Messrs. Pitman have been issuing for some time past, and it forms an exceedingly interesting description, explaining how the ever-increasing demand for the economical production of power and the steady rise in the cost of coal and oil have caused a correspondingly rapid growth in the applications of the internal combustion engine, owing primarily to its greater fuel economy. It deals in an historical sense with the development of the old-fashioned gas engine of the early days to the present wonderfully efficient types, as well as giving details of the speed control and ignition systems. There is also an excellent chapter on large gas engines, after which the author goes on to the crude oil, petrol and benzol, followed by a very practical explanation of the principle of the petrol engine. He describes aero engines, farm and traction engines, road transport, and then the well-known Diesel and semi-Diesel engines, turbines and auxiliary machinery. Altogether a very interesting book.

EXPERIMENTAL ELECTRICAL ENGINEERING AND MANUAL FOR ELECTRICAL TESTING. By V. Karapetoff. Third Edition. Vol. 1, 8vo, 795 pp., 391 figs. (Chapman and Hall, 30s. net.)—This book, though American in origin, is written and arranged by a scientist who is in a sense international, and as a natural consequence the previous editions have already met with a ready sale in Great Britain, since its first appearance in 1909 in one volume. The second edition, in two volumes, was published in 1911, and electrical science has made such marvellous progress during the last twelve years that one is not surprised at the growth in size of this third edition, which has been most thoroughly revised throughout. In its preparation the author has had the cordial co-operation and criticism of over one hundred teachers of electrical science, and it may, therefore, be taken without hesitation as representing electricity as it is actually taught in the American electrical colleges and laboratories. Other chapters have been revised by prominent manufacturers of various types of plant; indeed, one of the best points in the book is the independence of the majority of the chapters, which can in many cases be studied and mastered apart from each other, although forming part of a well-combined whole. It acts, therefore, as a most serviceable work of reference, and we are certain that it will be welcomed by a large circle of readers in this country, to whom we can recommend it most cordially.

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Various Items.

Cape Town.—The Corporation invite tenders for electric motors. Specification, etc., at the offices of the D.O.T (Room 52), 35, Old Queen Street, London, S.W. 1.

Department of Overseas Trade.—Some additional members have been appointed to the Advisory Committee of this important Government Department. Among these we notice the names of Mr. W. L. Hichens, who is the deputy chairman of the English Electric Co., Ltd., and Sir Wm. Pearce, who is a director of Messrs. Spencer, Chapman and Messel Co., Ltd., the well-known makers of accumulator acid

Finance.—The directors of the Charing Cross, West End and City E.S. Co., Ltd., are issuing 16,000 ordinary shares of £5 each, forming part of the unissued ordinary capital of the company, at the price of £7 10s. per share. They will be offered to the holders of the ordinary shares of the company as registered in the books on June 2, 1923, the holder of each complete five shares being offered one new ordinary share.

E.C.A. and E.D.A.—The Electrical Contractors' Association has now decided to make a joint subscription on behalf of the whole of its members to the funds of the British Electrical Development Association. This valuable addition to E.D.A. support will undoubtedly secure wider activity in the provinces, assist the Association in building up district sub-committees, and greatly increase the interest of all contractors in the work of their representatives on the E.D.A. Council and Committees.

I.E.E. Summer Meeting.—A charming booklet has been prepared by the Manchester and Liverpool local centres for distribution among the members of the Institution who are taking part in the summer meeting which is to be held this month. It contains brief historical notes in regard to Manchester and Liverpool, as well as descriptions of the places of interest in the immediate neighbourhood of both cities and of the factories, etc., which are to be visited during the course of the meeting. In addition, there are eight excellent illustrations, which add to the value of the book as a guide to those who are fortunate enough to be able to spare the time to join in what is certain to be a very happy gathering.

To Telephone Engineers.—Speaking of the first volume of Mr. William Aitken's book on *Automatic Telephone Systems* (Benn Bros., 1921, 25s. net), the *Post Office Engineers' Journal* congratulated the writer on "the production of the first English book dealing with this important subject in anything like a comprehensive manner," and added that the publication of the second volume would be awaited with interest. This second volume, which is now announced for publication by Messrs. Ernest Benn within a few weeks, deals with auxiliary services to private and branch exchanges. In its general plan it will follow the lines of the first volume, which is, we believe, already accepted as the standard work on its subject. The price will be approximately 25s. net.

Water Meters.—For some time past engineers who are believers in proper costing methods have been doing their best to increase the taking of records so as to keep a check on the efficiency of various operations, and for this it is essential that modern precision instruments should be used. It is, however, frequently stated that such precision instruments are too delicate and break down too frequently. This complaint most certainly cannot be made against a Kennedy water meter, which was supplied by Messrs. Glenfield and Kennedy, of Kilmarnock, to the blast-furnace department of Messrs. Dorman, Long and Co. in 1857. At the present moment it requires only average repair to put it in working order, and it has therefore actually been in operation over sixty-five years. This must surely constitute a record?

Railway Signalling.—Readers who are interested in the very important developments which are constantly taking place in this branch of electrical engineering, or who have friends likely to be so interested, should study the very well-written and up-to-date chapter on the use, care and maintenance of electrical railway signalling and communication apparatus which appears in the 1923 edition of the *Practical Electrician's Pocket Book*. It was specially written for the book by Mr. M. G. Tweedie, the Hon. Sec. of the Inst. of Ry. Signal Engineers, and represents the very latest practice. A copy of the book ought to be in every signal cabin in the kingdom. The price is only 3s. net from any railway bookstall, and in addition to the chapter referred to above it contains a vast amount of useful electrical information and data on such subjects as telephones, bells, batteries, wireless receiving, measuring instruments, testing, etc., etc.

China.—In order to provide current for power as well as lighting, the Wu Hsing City Electric Co. has increased its capital by $70,000.——The China Electric Co. is installing a wireless telephone system between Pekin and Tientsin.——The Jehol Telephone Co. has been registered.

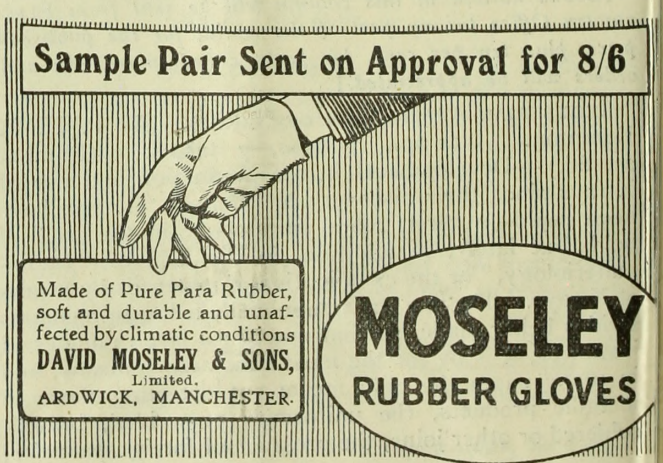
Holland.—A report of the Economic and Industrial Conditions of the Netherlands to February, 1923, has just been issued by the Department of Overseas Trade, and may be obtained from H.M. Stationery Office, price 2s. 2d. net, post free, or from ELECTRICITY office. It will be of direct interest to all who are doing their best to sell British electrical goods in Holland or who are in export trade competition with the manufacturers in that country.

France.—From the Dept. of Overseas Trade we have received a copy of the Report on the Economic Conditions in France to March, 1923, the price of which is 3s. 9d. post free from H.M. Stationery Office or from ELECTRICITY Office. It is a comprehensive pamphlet of 130 pp., and should, of course, prove of direct interest to all electrical manufacturers who are anxious to increase their trade with our great ally. Pages 62 to 64 contain lengthy details of the proposed introduction of electricity as the motive power on several of the French main lines, and on other pages there are sections dealing with manufactures generally.

To Power Users.—Mr. H. H. Broughton's great work on *The Electrical Handling of Materials* (Ernest Benn, Ltd.), has been described in *Engineering* as "the most successful attempt that has yet been made to deal exhaustively with the many problems connected with electrical handling." To the first three volumes dealing with electrical equipment, structural steel work and mechanical equipment, and electric cranes, is now added the last and final volume of the series, which deals with the handling and storing of bulk materials. The price of this volume, which is uniform in size with the third volume, is 50s. net. The same firm will shortly publish *The Poulsen Arc Generator*, by C. F. Elwell, M.I.E.E., etc., the first book yet produced on the subject. The object of the author, who is, perhaps, more responsible for its practical development than any other one engineer, is to give a complete idea of how the Poulsen arc generator works, as well as to record the many forms which different designing engineers have given to it.

Trade Notes.

The **Simplex Electric Co.**, of 54, Sandy Park Road, Brislington, Bristol, are placing on the market a novel and at the same time eminently practical line, which they call the "Andy" fuse-wire wallets. They are miniature affairs, size 1¾ in. by 1¼ in., and are made up with a supply of 5- and 10-amp. tinned copper fuse wire, being the average size used in general service, with a card of information and fuse-wire tables, the blank spaces on which can be filled in with appropriate wording. The name and address of the electrician, dealer or other—not exceeding ten words—can be gold-blocked on the back of each case. In view of the fact that the replacement of a fuse is fast becoming the work of the layman in whose house current is installed, there should be quite a demand for these wallets, and all contractors and dealers in electrical supplies, as well as ironmongers and stores who sell electric lamps, should be able to dispose of them in quantities.



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A POPULAR SCIENTIFIC WEEKLY JOURNAL OF
ELECTRICITY
A PRACTICAL TRADE JOURNAL

JUNE 8, 1923.

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THE ELECTRICAL RESISTANCE OF TRAMWAY STEEL.

Since the tramway track is, in most cases, used as the negative, or return path to the generating station, the resistance and composition of the steel forming it will have a bearing on the current values and the corrosion to which it may be subjected by the electrolytic action of the current.

Both chemical composition and hardness change the electrical resistance of the material, the greater the impurity and the harder the steel so the resistance increases. The following composition is allowed to be the best for tramway rails, viz. :—

Iron 99.43 ; Silicon .04 ; Sulphur .05 ; Phosphorous .05 ; Manganese .3 ; Carbon .13.

The specific resistance of steel of this analysis is about equal to eight times that of copper, while it is interesting to note that chemically pure iron—a substance unknown in commerce—is only four-and-a-half times. Ordinary steel plate is about ten times, and it will thus be seen that the materials and their amounts exercise a marked effect on electrical resistance. The element which raises it most is manganese, and no steel should be employed where the percentage of manganese is greater than the above.

Although the resistance is increased by hardness, and on that account hardness should be avoided, yet physical considerations demand that the rails shall have good wearing qualities, so that we have to steer a mid-path in the selection of our steel.

The following three empirical formulæ connect together the resistance and weight of steel, viz. :—

$$R \text{ (ohms)} = \frac{.0025}{W}$$

$$R \text{ (ohms)} = \frac{.833}{W}$$

$$R \text{ (ohms)} = \frac{4.4}{W}$$

W in each case being the weight of the rail in pounds per yard, and the several R values being the resistance of 1 yard, 1,000 feet, and 1 mile of the steel respectively.

Having regard to the fact that there are two rails carrying the return current, the above numbers will be halved, this follows from our knowledge on joint resistance.

Resistance of joints.—With cast-welded and electrically welded rail joints marked differences occur when comparing their resistance with the same length of steel rail. It is found that in the former case the resistance increases, while in the latter it is actually less than the same length of steel. Thermit-welded joints, on the other hand, follow the same law as with cast-welded joints. The following values illustrate this, viz. :—

Cast Welded.	*Thermit Welded*	*Electrically Welded.*
3′ of Rail containing *Joint* .0000275 ohm.	3′ of Rail containing *Joint* .0000377 ohm.	3′ of Rail ontaining *Joint* .0000311 ohm.
3′ *of Solid Rail* .0000251 ohm.	3′ *of Solid Rail* .0000316 ohm.	3′ *of Solid Rail* .0000407 ohm.

Rail Bonds.—These are connections carrying current from rail to rail, these ensure good electrical contact as copper is used in the construction of these bonds. Should the bonding be poor, power (C^2R) will be lost there, a poor bond giving, comparatively, a high value for R. On no account should there be a drop of more than 7 volts in the rails, as the motors will thus get less voltage, and this in turn will reduce the speed.

Electrolysis.—This is a subject to which much attention has of late been given ; it is closely related to poor bonding, some of the return current leaking to earth, and in its passage bringing about a chemical effect on moist materials in the neighbourhood of the track, more especially where there are lead-covered cables or lead pipes carrying water.

Electrolysis manifests itself by decomposing salts in the damp earth, and by the metals near becoming pitted, gradually being eaten away. This is especially the case with lead and tin, it is said that 75 lb. and 42 lb. respectively can be eaten away per year by a current of one ampere maintained for that time.

Leaky tramway currents certainly contribute to this "pitting" of metals near the track, especially where the return circuit is poor. Suppose there is a metal pipe near by with, say, a poor bond ; some of the current will leave the rail, pass through the earth and enter the pipe, the path will then be—further end of pipe—earth—rail, and back to the generating station, Electrolysis will occur at two places : (1) where the current *leaves* the rail, (2) where the current *leaves* the pipe.

Prevention of electrolysis.—Leaky currents are now so much reduced that their amount is almost negligible, and therefore their chemical effect is lessened. As already mentioned, it is recommended that the voltage drop in the rail shall not exceed 7, and the voltage between metal pipe and rail 4½, and lastly, the Board of Trade specify that the current returning via earth shall not exceed 2 amperes per mile.

More Motor Ship Orders.—There appears to be little doubt that since the beginning of the year more orders have been placed for motor ships than for steamers. According to *The Motor Ship*, a commencement was made last month upon 13 new oil-engined craft, totalling 96,500 tons deadweight, and of these eight are being built in British yards.

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THE CLYDE VALLEY E.H.T. INTERCONNECTOR AND ITS PROTECTIVE SYSTEM.

(*Concluded from page 292.*)

The relays are of the beam type, with main and restraining coils. A relay with cover removed is seen in Fig. 3, while in Fig. 4 it is shown in position on a pedestal on the switchboard gallery. The beam and coils are securely built up on the laminated iron circuit which forms the basis of the apparatus. The beam is of aluminium, with substantial pivots capable of withstanding the heavy forces likely to be set up when a short circuit occurs.

The coils are wound upon bobbins of solid black bakelite. Their flanges are shaped for fitting into place on the laminated framework with a minimum of fixing. A particular feature is the entire avoidance of eddy current losses, which often occasion trouble in metallic bobbins.

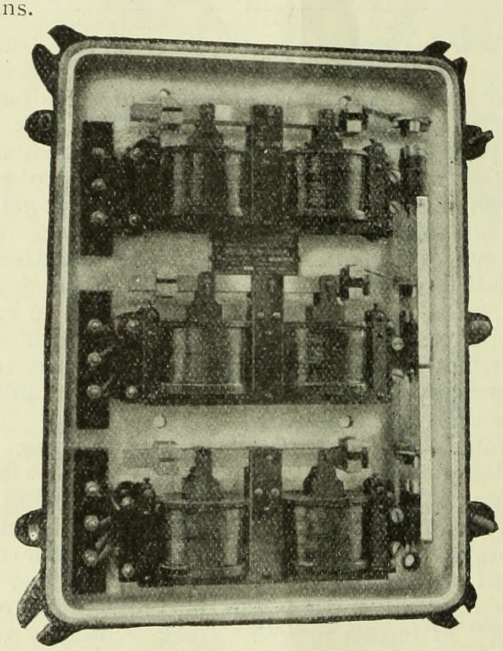


FIG. 3.—BEAM RELAY GEAR WITH CASE OPEN.

Moulded insulation is also used for the terminal blocks on the left-hand side of the cases, also for the trip contact supports on the right. These latter are usually designed to take carbon contacts, this material being the only one available definitely free from sulphurous corrosion which produces an insulating film on metals. Silveroid, which is the most satisfactory metal from this point of view, is used for low tripping voltages.

From the illustration at Fig. 3 it will be seen that the fulcrum pins have been displaced from the middle of the beam away from the restraining coil. This displacement is sufficient to give the latter a 5 per cent. bias over the operating coil; further regulation of the bias may be obtained by the duplicate resistances to be described.

The requisite number of duplicate resistances at one end of the feeder (*e.g.*, three for a three-phase circuit) are contained in a box similar to that used for an ordinary motor starter resistance (see Fig. 5). On the top, which is of slate, are fixed three links so arranged that either the normal resistance may be inserted or the resistance may be regulated to increase the bias of the relays by allowing a greater percentage of the transformer current to be diverted through the restraining coil.

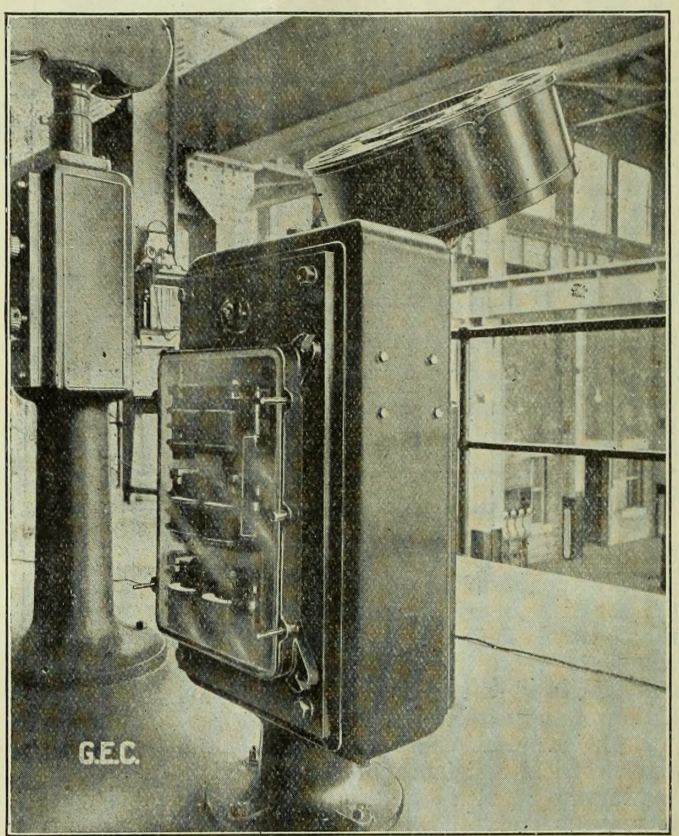


FIG. 4.—BEAM RELAY MOUNTED ON STAND ON SWITCHBOARD GALLERY AT CLYDE VALLEY POWER-HOUSE (CLYDE MILL).

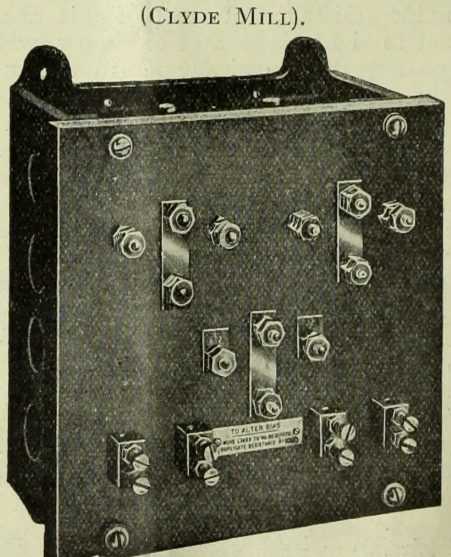


FIG. 5.—DUPLICATE RESISTANCE BOX.

It has been considered better to employ screw-up links for the faceplate in preference to sliding contacts. The former are more reliable electrically, and less likely to be interfered with.

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The instrument transformers are made at the G.E.C. associated Chamberlain and Hookham Works and are specially designed for large power circuits. They are of the tube type and are styled Type "T" (Fig. 6). There have been many breakdowns in the past due to the fact that sufficient attention has not been paid to installing instrument transformers of very robust construction on such circuits. The primary consists of a few turns of copper strip passing through bakelite tubes. The tubes are of sufficient length to withstand a flash-over voltage greater than five times the normal working voltage, and are thus capable of dealing with

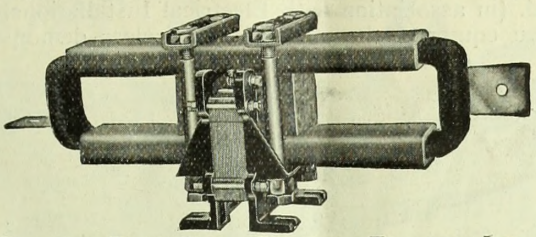


FIG. 6.—TUBE TYPE CURRENT TRANSFORMER.

surges and other transient phenomena. Further, they are mechanically very strong, non-hygroscopic and have a high factor of safety. To resist the forces tending to disrupt the primary winding under short circuit conditions, the two long sides of the rectangular coil are supported by four large steel bolts, the tubes being maintained in their correct position by spacing pieces. The secondary consists of a former wound coil impregated with insulating varnish, after having all moisture removed in a vacuum chamber. This process results in all the interstices of the coil being filled with varnish, and freedom from breakdown is assured.

The core is built up of non-ageing silicon steel stampings, and the joints are imbricated in order to reduce their magnetic reluctance. After assembly, the core is clamped between two substantial brackets provided with feet for bolting the transformer on to its support. The transformers are shown in position in Fig. 7.

The laying of the cable gave rise to several problems, especially along the banks of the River Clyde. Two lengths of cable were made specially to cross the river, being double wire armoured instead of steel taped.

The type of joint decided on was of plain and simple construction, in which the three cores of the cable are divided out and jointed in a horizontal plane. After the joints were made a lead box was put round them, compound poured in, and a containing cast iron box placed in position outside.

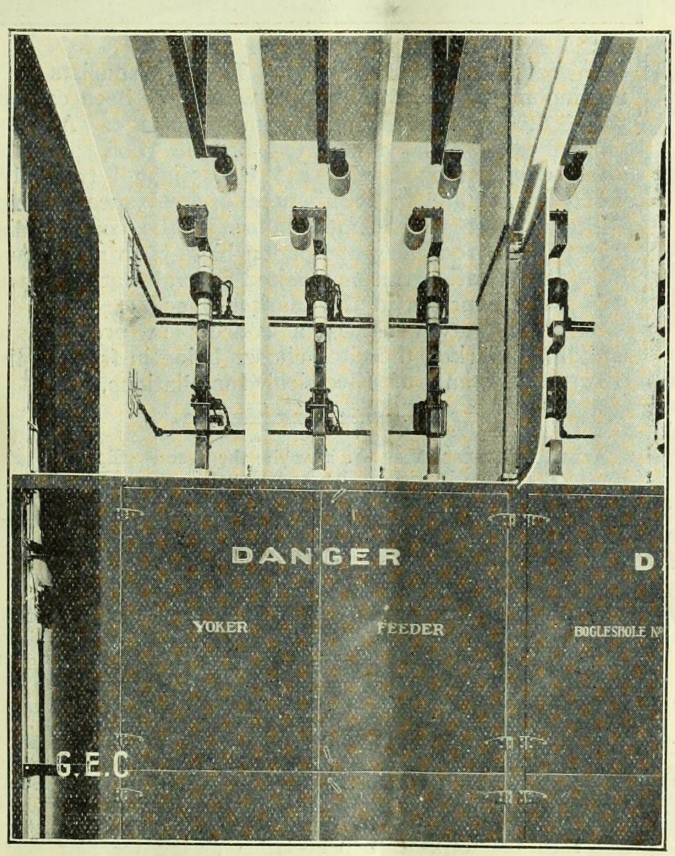


FIG. 7.—TUBE TYPE TRANSFORMER SHOWN IN POSITION.

MR. MARRYAT IN IRELAND.

Mr. H. Marryat, the president of the E.C.A., has just returned from visiting the contractors in Ireland, where he was enthusiastically welcomed both in Belfast and Dublin. In Belfast particularly he found the contractors to be well together and on the best of terms with each other and with Mr. Johnstone Wright, the city electrical engineer, and the local supply houses. The work carried out is of a high class, and generally he is of opinion that Belfast can teach many of the English branches of his association a good deal. In that city a lunch was arranged, at which Mr. Johnstone Wright and he were honoured guests. The majority of the contractors were present, and it was evident from the speeches which were made that the utmost good will existed between all parties.

At Dublin the contractors have formed their own local association, only a few members of which belong to the E.C.A. This position has arisen owing, to some extent, to the local workmen's organisation having broken away from the E.T.U. It is expected, however, that some arrangement will be made to enable the Dublin contractors to join or affiliate with the E.C.A.

BOOK PRINTING.

The present high cost of printing which is acting as such a heavy handicap, more particularly to technical education, is fortunately having a stimulating effect on the minds of inventors, who think that they see therein an excellent opportunity of designing some printing process which will avoid the type-setting entirely and thus eliminate the most costly portion of the work. This is simply the inexorable working of natural laws which employers' rings or trade union rules cannot overcome, and it is to be hoped that the new process, of which we have just received details, will be developed efficiently and rapidly. Unfortunately it is German, but it is being exploited by one of the largest printing firms in Berlin, with over 1,300 employees, and it is almost certain that a process such as this will be taken up by some go-ahead English printer, who will probably reap a big harvest as a reward of his enterprise. The actual specimens of

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work which have been submitted to us include an illustrated engineering catalogue page, music, and a technical book page, full of algebraical workings, and they are really wonderfully clear. Language is, of course, no difficulty. The firm in question is prepared to carry it out in every language of the world, and for that matter we expect the people who might introduce the process into this country would undertake to do the same. It must be remembered that this is not a question of English wages comparing with German wages. It is an invention which will cut the cost of composition, and that is what we have to consider.

DEVELOPMENTS IN ILLUMINATING ENGINEERING.

The report of the Council presented at the annual meeting of the Illuminating Engineering Society on May 24 showed how many are the directions in which the study of applications of light is extending. During the past session such varied subjects as Training in Illuminating Engineering, the Lighting of Streets and Printing Works, the Predetermination of Daylight Illumination, and the Projection of Light have been discussed. At this meeting entirely new ground was broken by the fascinating paper by Dr. J. F. Crowley dealing with the use of intermittent light in industry.

The strobscopic effects produced when moving objects are illuminated by intermittent light are familiar and have been made good use of in various devices applied to alternating current machinery. But Dr. Crowley showed that the idea is now having new and striking applications in the textile industry and elsewhere. It is common knowledge that when high speed machinery is illuminated by light fluctuating in synchronism with the speed of the machine, the latter may appear to be stationary; or, if the speed of the light is slightly above or below synchronism, the parts may appear to be moving very slowly backward or forward.

In the oscilloscope, an apparatus utilising a neon lamp fed by alternating current, this phenomenon is applied to the study of motions of machines which would be quite indistinguishable by steady light. When the complex machinery used for textile and other industrial operations goes wrong the remedying of the defect is often extremely tedious. Sometimes the only proof of the defect is the spoiling of the work, and trial adjustments must be made until the motion is corrected. An experimenter in these circumstances is working in the dark. But in synchronously intermittent light he has a new and valuable weapon. The motion can be apparently slowed down until the working of parts of the machine is revealed to the eye, and the operator can actually *see* the defect occur. The apparatus is relatively simple, and it was stated that in many factories twenty or more were often used.

Another item on the programme was a demonstration of the use of the Hilger-Nutting spectro-photometer by Mr. P. R. Ord. It was shown how by this apparatus the distribution of luminosity throughout the spectrum of natural daylight, artificial daylight and other illuminants can be compared and studied, and Mr. Ord presented a series of curves illustrating the degree of approximation to average daylight than can now be obtained by artificial means.

AN ATTRACTIVE PORTABLE BROADCASTING DEMONSTRATION VAN.

There is no more effective method of publicity for wireless broadcasting receivers than actual demonstrations with the sets, and wireless dealers throughout the country, keenly alive to the fact, are arranging suitable demonstrations whenever an opportunity offers.

Unfortunately, in many more remote and scattered regions it is difficult to obtain suitable premises for these demonstrations, but Messrs. Wireless Service, Ltd. (in association with Electrical Installations, Ltd.), have equipped the very novel wireless demonstration



van shown in the illustration. The van consists of a touring motor-car, the body of which has been camouflaged to look like a small country cottage. A short but efficient aerial is erected on the roof, and the interior is equipped with a "Gecophone" two-valve receiving set and full equipment of loud speaker, etc.

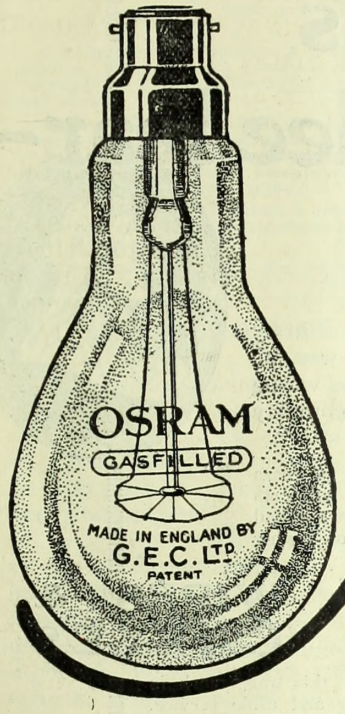
Some successful business tours in the country districts within 100 miles of London have been made, and the demonstration van has visited several market towns and given concerts in the market-place.

The illustration shows a concert in progress at Guildford Market, the pitch chosen being in front of the permanent stand of Electrical Installations, Ltd.

Annual Summer Visit.—Through the good offices of the President, the British Thomson-Houston Co., Ltd., have extended an invitation to members of the Birmingham and District Electric Club to visit their Rugby works on Wednesday, June 20, by train leaving New Street Station at 12.30, and the B.T.-H. Co. are kindly providing lunch for the party on arrival at the works.

The British Engineers' Assocn.—The eleventh annual general meeting of this association was held at the Hotel Victoria, London, on the 31st ult., when Mr. E. W. Petter was unanimously elected president of the association, in succession to Mr. Nevile G. Gwynne, C.B.E., who had occupied that position for the past two years. Mr. H. J. Ward, of Messrs. J. and E. Hall, Dartford, was elected chairman of the Executive Committee in the place of Mr. Petter. Notwithstanding the effects of the long continued industrial depression, from which the engineering industry has suffered so severely, the Council were able to present a satisfactory report on the work of the association during the past year, together with accounts disclosing a sound financial position, while a spirit of optimism prevailed in regard to the future of the association and its value to the engineering industry.

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An 'all round' improvement

– the departure of the 'pip'

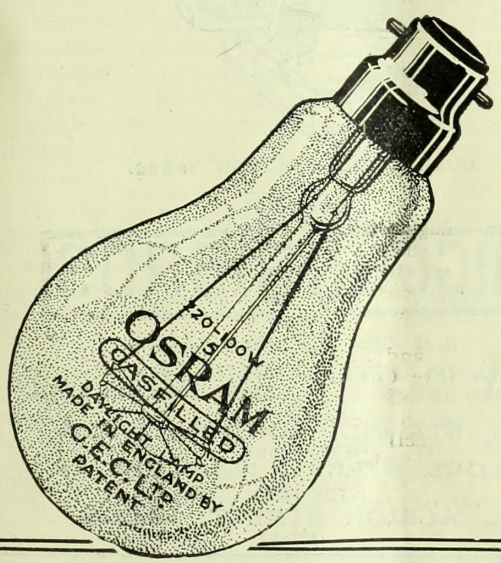
THERE is no halting in the march of OSRAM progress. Improvements, born of continual research, experiment and trial are constantly being applied.

Another new departure is now announced —the departure of the pip from the 100 watt OSRAM Gasfilled Lamp. Henceforth all Lamps of this size will be pipless.

The necessary new machinery—installed at great cost for this change over—will in due time be applied to the production of all other sizes of OSRAM Gasfilled Lamps.

Resellers and Users everywhere will welcome this innovation, since the absence of the projecting pip means easier handling, and less risk of breakage, while the general appearance of the lamp is greatly improved.

NOTE.—We reserve the right to supply "pipped" 100 watt Lamps until the present limited stock is exhausted, after which the pipless variety will be exclusively supplied.



Osram
G.E.C.
GASFILLED LAMPS

Advertisement of the General Electric Co., Ltd., Magnet House, Kingsway, London, W.C.2.

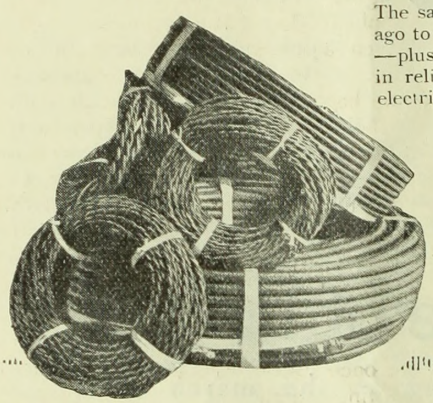
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HENLEY V.I.R. Wires installed in Jubilee Year—

and as efficient to-day as ever



36 YEARS AGO the first wiring installation in the town of Bedford was put in by Messrs. H. Bacchus Ltd., with Henley Wires, on their own premises. It was run in wood casing, and the current was supplied from their own plant. The same wiring was used when they changed over to the Corporation supply, and it is as good to-day as when it was first installed. **Truly, time tests all things.**



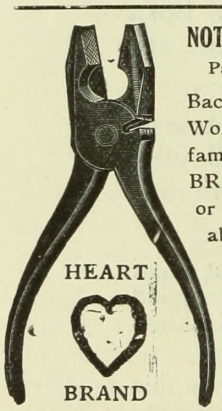
The same qualities that made it possible for the Henley Cable of 36 years ago to be giving good service this year, are found in the modern products —plus all that the intervening years of research and experience have added in reliability and enduring electrical efficiency. To be sure of having electrical transmission that, once installed, you can forget—use

HENLEY WIRES & CABLES

The information contained above offers confirmation that this trade mark is your protection and guarantee of trouble-free wiring and cable service.

W. T. HENLEY'S TELEGRAPH WORKS COMPANY LIMITED.
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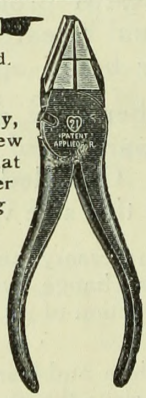


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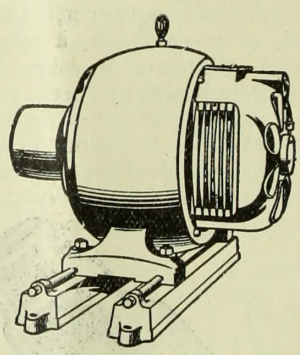
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TO OUR READERS.

ELECTRICITY is published every Friday, and, if ordered, is on sale at the principal Railway Station Bookstalls and Newsagents on that day. It has a very large sale throughout the United Kingdom, as well as in the British Colonies and Abroad.

New advertisements for the displayed columns and alterations to existing ones must reach the publishing office not later than first post Tuesday morning, in order to be in time for the issue of the following Friday. This is important. Rate quoted on application. Subscription: 13s. a year, 6s. 6d. half year, 3s. 3d. a quarter in advance, postage prepaid in the United Kingdom and abroad.

Questions to which an answer is required must be accompanied by a 1½d. stamp for reply. When considered of sufficient interest, the answer will probably appear in the paper.

All remittances payable to the Publishers, S. RENTELL AND CO., LTD., 36 39, Maiden Lane, London, W.C.2. Telephone No. 2460 Gerrard.

Current Topics.

Industrial Grouping and Competition.

The modern tendency is for various industrial undertakings to range themselves into several large groups or combines, often with works and branches spread about in various parts of the country, the fundamental idea being that such combination of interests tends to strengthen the position of the particular industry represented, and that administrative economies can be effected by thus putting all the eggs as it were in one basket. The general principle of grouping is all right provided it is legitimately confined to one industry, or particular branch of the industry, but, unfortunately for the electrical section, most of the existing groups cover a very wide field of manufactures, and although each unit of the group has, perhaps, a principal product, be it cable, heavy electrical plant, lamps, or accessories, they each run a series of side lines quite apart from the fundamental product, and in the manufacture of which they also enter into competition one with another.

Now fair and open competition, on equal terms, is good for everybody concerned, inasmuch as it stimulates progress and development in designs, the cheapening of manufacturing costs, selling expenses, and the elimination of undesirable products. The form of competition above outlined, however, cannot be classified as on fair and equitable terms; it usually degenerates into a matter of prestige, and the pitting of one concern's financial resources against those of its rival. Take an imaginary case to point my moral: a small firm whose original industry and principal product is electricity meters is absorbed by one of the big groups. Belonging to another rival group is a factory wherein competitive meters are produced as a small side line to the main product which may be anything, perhaps switches and switchgear. Financially the second group is mightier than the first, and the fiat goes forth that there is to be keen competition to oust the original meter manufacturer and capture his market.

In the natural order of things, assuming that both main concerns are efficiently managed, the legitimate meter interests would hold their own. They are specialists in the trade, have been established for perhaps a quarter of a century or more, are abreast of the times in meter design and manufacture, and indulge in a reasonable amount of advertising. But the powers have spoken, the market is to be secured at all costs, and a ruinous and ridiculous price-cutting campaign, supported by costly and specious advertising, is conducted by the wealthier group until, eventually, the original meter factory succumbs and the new production reigns in its stead. Then follows the master stroke of the financial mind. Having thus falsely established its claims, the newcomer is floated as a new and immensely profitable venture on its own, and the founders pocket their ill-gotten gains, what time the old-established and legitimate meter manufacturer seeks fresh woods and pastures new whilst his erstwhile employees draw their weekly doles.

In the above example, which is of course a purely supposititious case, but nevertheless has its several parallels in actual fact to-day, I have endeavoured to throw some light on one of the greatest evils of the modern industrial grouping system as applied to the various branches of the electrical trade. It is impossible in these large industrial groups, with their many ramifications, to arrive at the true cost of production of a comparatively insignificant side line. The general overheads are too complicated and the organisation too unwieldy to permit even approximate costing of any save the main product. As a consequence most of these groups would be hard put to it to calculate the true cost of some of their more insignificant products, and competition in those products is conducted more or less on the "swings and roundabouts" principle, the interested branch being subsidised at the expense of the more remunerative main product. Such insensate competition is neither good for the industry affected nor for the individuals engaged in it. They are mere pawns in the financier's game.

Too Many P.M.G.s.

The *Daily Mail* has once more struck the right nail on the head in promoting criticism of our present system of controlling that vast national business, the Post Office, through the medium of a transient political head whose term of office is an unknown quantity and may be limited to a few short months. As a matter of fact we have had three different Postmaster-Generals in the last seven months, and none of them has been long enough in office to master the main details even of the vast business of which he was for the time being supreme head. No private enterprise would tolerate such a rapid change of management, and it stands to reason that Post Office efficiency must necessarily suffer in the process of frequent change. Moreover, the political head of the Post Office is mainly concerned with the policy of the Department he controls, and no policy can be established, let alone maintained, on such a basis as the present one of changing control with every re-arrangement of the Cabinet.

As a business undertaking affecting the interests of every man, woman and child in the country, the Post Office interests are mainly non-political, and there is no logical justification for vesting its management and control in a high political personage, and one who has in many instances to rely upon his subordinates for instruction in the duties of his office. The system under which this great business undertaking is controlled by a short-term Cabinet minister is probably responsible for many of the criticisms which have been levelled against it in the past. Under constantly changing management it has no opportunity of making good and showing what it really can do in the matter of reforms, efficiency and improved administration.

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The system cannot be excused on the plea that the Postmaster-General at any given period is only a political figure head, and that the business is really managed by the regular executive officers.

Any Postmaster-General who is worth his salt will strive to justify his appointment, no matter how brief his term of office, and, in order to do so, he must necessarily have a policy of some kind and attempt to graft that policy upon the existing organisation. He is the intermediary between the Post Office and the Treasury. If development schemes require expenditure, as they almost inevitably do, then it is his business to see that the necessary sanction is obtained from the Treasury. In the circumstances it is easy to see that the real progress of events in the Post Office organisation, vast as it is, might very readily be checked, or even reversed, by a sudden change in this office of Postmaster-General. As a matter of fact this question of Cabinet Office over a business organisation which ranks as the largest in the country serves to emphasise the fact that politics enter far too largely into business in these times.

The same criticisms apply, in a smaller degree, to local government and municipal appointments. I contend, and I think rightly, that politics should not enter into a municipal election at all. The object of a municipal election is to elect a business representative for a given community, a man who will do his best to help manage the various business undertakings which are the property of the ratepayers as a body, and not a partisan of Labour, Communism, Conservatism or Liberalism. Politics enter far more largely into our daily business interests than they have any right to do, and that is one of the reasons why, as a victorious nation, we are individually so poverty-stricken, as are the majority of Britons to-day.

Permalloy.

Probably you have never heard of permalloy. Neither had I, until I saw a recent issue of the Journal of the Franklin Institute, but it is certain that we shall hear a great deal about this remarkable material in future. As its name implies, permalloy is a permeable alloy. It is a nickel-iron alloy containing about 80 per cent. of nickel, and its permeability at low values of magnetic field strength is many times greater than any hitherto known. So extraordinary is the material that it approaches magnetic saturation when the only magnetisation to which it is subjected is that of the earth's field! The saturation value of the magnetic flux in the metal itself is roughly 70 per cent. that of iron.

Nor does this complete the tale of wonder, for it is found that the hysteresis loss at a maximum induction of 5,000 gauss is only one-sixteenth that of soft iron, and the permeability of permalloy at this flux density is about 85,000, which greatly exceeds that of silicon-steel. I need hardly say that this material, with its phenomenal permeability and the great sensitivity of its magnetic properties to change by mechanical stress, heat treatment, etc., offers the prospect of remarkable developments in the field of telegraphy, telephony and electrical measurements. Also, I see no reason to doubt that permalloy will find applications in heavy engineering equipment. Further information will doubtless emerge in due course from the laboratories of the American Telephone and Telegraph Co. and the Western Electric Co., where the discovery of permalloy was achieved.

The 10 H.P. Voice.

Whatever our impressions after listening to the tirades of the stump orator, the 10 h.p. voice is not and can never be an actuality. By using our old friend the vacuum tube amplifier, Crandall and MacKenzie have succeeded in obtaining a total-energy record of the human voice speaking a sentence. Incidentally they find that the greatest part of this energy is radiated at a frequency near 150 by a man's voice. Cynics will not be surprised to hear that one lady's voice contributed considerable energy at a frequency of 2,000. Without attempting to find a moral in this, let us turn to the final conclusion reached by these investigators, viz., that the normally modulated voice sends out about 125 ergs a second.

Unless my arithmetic is at fault, four million people speaking simultaneously, each in politely modulated tones, would give out, in the form of sound, as much energy as is consumed by a single 50 watt lamp! An orator of the most vociferous type could bawl away for 24 hours or more with the expenditure of less than one foot-pound, and if he would only "eat coke," as his audience implores him, he would take in with 1 lb. of that admirable fuel sufficient energy (say, 10,000 B.Th.U.) to keep a well modulated voice going for 27,000 years or so. Even allowing for the extra consumption demanded for strident effects there would be ample energy for 15,000 years. That the limitations of the human digestion prevent him from effecting this conversion is clearly a merciful dispensation of Providence.

ELEKTRON.

VACUUM CLEANERS FOR TELEPHONE EQUIPMENT.

According to a recent issue of *Telephony*, of Chicago, a new and different type of vacuum cleaner, weighing only 6½ lbs., is now being used for cleaning telephone equipment. In place of the usual long handle with which the standard electric cleaner is equipped, the new cleaner, known as the Premier Handy Electric Vacuum Cleaner, has a handle resembling that of an electric iron. It is supported by a strap over the operator's shoulder, and is manufactured by the Electric Vacuum Cleaner Co., Inc., Cleveland, Ohio. It was designed originally for cleaning the upholstery of closed cars and for cleaning pool and billiard tables. But a certain telephone company saw its possibilities for cleaning telephone equipment and apparatus and placed an order for several of these machines.

The results produced were so satisfactory that the manufacturer saw another field for it which looked nearly as large as that of the automobile field. A short fibre section and rubber tool were added to the cleaner's equipment, and various samples were sent to equipment supervisors and maintenance supervisors of telephone plants in different sections of the United States.

The reports on its operation were most affirmative, so the Electric Vacuum Cleaner Co. immediately began

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an intensive cultivation of the telephone field, with the result that a great many of the machines are now saving time and expensive equipment in telephone exchanges in nearly all sections of the country.

The Premier Handy may be used both as a suction cleaner or as a blower. In using it as a blower, it is necessary only to remove the bag, attach the blower coupling, put on the hose, and a powerful blast of air is available for cleaning surfaces that are inaccessible to the suction tools.

It is supported at the operator's side and out of the way of equipment. The operator may stoop, climb a ladder with it, or get into otherwise inaccessible places, due to its compact construction and to the unique method of its use.

LITTLE TROUBLES.

DON'T LET THEM GROW INTO BIG ONES.

It is a fact that if a weed is left alone it spreads, and in course of time may occasion a deal of trouble. In the factory also, the little trouble which is ignored becomes in time a formidable proposition, and the wise manager, recognising this, makes up his mind to "nip" the trouble whilst it is small enough to be handled with ease.

The attempt to eliminate the small trouble oft-times excites the scorn and derision of the operators and the minor staff officials. They protest against being "pulled up" for petty delinquencies, arguing that the trouble is "not worth it," and they favour the foreman or department head who likes to do "*big* things" and who does not worry himself about trifles. Little things being beneath his notice, they have every opportunity for development, which no doubt accounts for the large number of "big things" which are for ever demanding his attention.

One man is a turner, and he is in the habit of leaving short ends of steel lying about. His foreman is too intent upon "big" things to notice such a small matter, and he takes action only when a piece of steel gets beneath the feet of some individual, and bodily damage, consequent upon a fall, is sustained. The foreman who appreciates the probable result of steel lying about, and takes the offender to task, is looked upon as an interfering and pettifogging individual, and his efforts incur the dislike of the men under his control.

In like manner also is the foreman who insists upon machines and machine tools being kept clean and in good condition condemned. He is known as a trouble-monger, for his reasons are not appreciated. Yet it should be apparent to anyone that, apart from prolonging the life of the machine or tool (which, perhaps, is not of absorbing interest to the operator), the well preserved machine or tool renders good service to the operator, by enabling him to turn out better work, at a higher speed, and with less effort.

"Do it *this* way" causes annoyance to the person accustomed to "do as I like." The latter is apparently "just as well," and for the moment is equally effective, but the effect upon the actions of others must not be disregarded. A person may be a great individualist whose personal achievements are of no mean order, but if those achievements are gained at the expense of someone else, the net result is not very pronounced.

This person is an energetic, bustling sort of individual who believes in getting things done; but in so doing he has a fine disregard for the rules and regulations which are considered necessary to the success of the enterprise. Thus one rule is entirely disregarded, another but partially observed, and a third interpreted in a manner quite foreign to the original intent—all with a view to achieving immediate success. If this is allowed to continue, the whole department or factory would soon become disorganised, and the "immediate success" be but the forerunner of colossal failure.

There are many other little troubles which require drastic handling—in fact, every shop has its share. They must receive constant attention, for the moment they are left alone they commence to grow and spread. It behoves every manager, foreman and department head to wage ceaseless war, even at the risk of making himself unpopular; and it behoves the operator to assist rather than to condemn, to recognise that he individually is concerned, and that "do as I please" is a dangerous doctrine, for it cannot be kept within any defined limits.

We are all more or less upon our dignity, and some perhaps are more easily ruffled than others. There are many phases of the factory organisation which upon the surface appear somewhat ridiculous, and many acts of the department head which appear to tamper with the liberty of the subject. Before condemning, however, would it not be wise for us to endeavour to understand? And then, in all probability, we should view matters from a different standpoint, and have an opportunity of appreciating the motive.

THE PRINCE OF WALES STARTS A 12,000 H.P. MOTOR.

During his recent tour in Sheffield, H.R.H. the Prince of Wales visited the large steel works of Messrs. Hadfields, Ltd., and started a new rolling mill which is driven by an electric motor of twelve thousand horse-power capacity.

A remarkable feature of this huge motor is the fact that in spite of its weight of 182 tons, it is capable of reversing from a full speed of 120 r.p.m. in one direction to a similar speed in the opposite direction in the incredibly short period of $2\frac{1}{4}$ seconds.

A further feature of the electrical equipment of this mill, all of which was supplied by the British Thomson-Houston Co., Ltd., is the method of reducing the enormous currents which would be required from the supply mains for short intervals during the rolling operations. A 30-ton flywheel, the rim of which runs at a speed of $3\frac{1}{2}$ miles per minute, or 210 miles per hour, is coupled to the generators which supply the mill motor. When heavy loads are experienced, part of the power required is supplied from the energy stored in this flywheel, and during periods of light load the speed of the flywheel is increased, and the energy thereby restored.

In this manner instead of excessive variations in the power required from the power mains the current is limited to that required for average loads.

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THE I.E.E. PREMIUMS.

The Council of the Institution of Electrical Engineers have awarded the following premiums for 1922-23 :— The Institution Premium (value £25) : To the late Dr. G. Kapp, for his paper on "The Improvement of Power Factor." The Ayrton Premium (value £10) : To F. Creedy, for his lecture on "Variable-Speed Alternating-Current Motors Without Commutators." The Fahie Premium (value £10) : To Dr. H. W. Nichols, for his lecture on "Transoceanic Wireless Telephony." The John Hopkinson Premium (value £10) : To J. Rosen, for his paper on "Some Problems in High-Speed Alternators and their Solution." The Kelvin Premium (value £10) : To S. W. Melsom and H. C. Booth, for their two papers on "The Efficiency of Overlapping Joints in Copper and Aluminium Busbar Conductors," and "The Rating of Cables for Intermittent or Fluctuating Loads." The Paris Premium (value £10) : To J. Caldwell, for his paper on "Electric Arc Welding Apparatus and Equipment." The Webber Premium (value £10) : No award. Extra Premiums (value £5 each) : To L. Breach and H. Midgley, for their paper on "The Drive of Power Station Auxiliaries" ; to Dr. F. T. Chapman, for his paper on "The Production of Noise and Vibration by Certain Squirrel-Cage Induction Motors" ; to Mr. A. T. Dover, for his paper on "A Universal Chart Method of Calculating Starting Rheostats for Direct-Current Motors" ; to Mr. P. J. Robinson, for his paper on "The Maintenance of Voltage on a D.C. Distribution System by means of a Fully Automatic Sub-Station."

WIRELESS PREMIUMS.

A Premium (value £10) : To Dr. N. W. McLachlan, for his paper on "The Application of a Revolving Magnetic Drum to Electric Relays, Siphon Recorders and Radio Transmitting Keys." A Premium (value £10) : To E. B. Moullin, M.A., for his paper on "A Direct-Reading Thermionic Voltmeter and its Applications." Extra Premiums (value £5 each) : To Prof. C. L. Fortescue for his paper on "The Design of Inductances for High-Frequency Circuits" ; to J. Hollingworth, M.A., B.Sc., for his paper on "The Measurement of the Electric Intensity of Received Radio Signals."

The premiums for papers read before the Students' Sections will be announced later.

"The I.E.E. Journal."—Part 318 for May, 1923, has just been issued (price 10s. 9d., post free), and will be appreciated by all who are interested in the permissible loading of British Standard Impregnated Paper-Insulated Electric Cables, because the second report on the research on the heating of buried cables issued by the Electrical Research Association is herein reprinted at length as presented, together with the lengthy discussion thereon. There is also the Report of the Instn. Council for the year 1922-23 and the annual balance-sheet, which shows a remarkably healthy state of affairs, and is a credit to the business-like way in which its affairs are managed.

Poland.—A report on the Industrial Situation in Poland has just been issued by the Department of Overseas Trade, and may be obtained, price 1s. 8d., post free, from H.M. Stationery Office, or from ELECTRICITY office. On page 15 details are given of the conditions in the electrical engineering industry in that country. During 1922 more types of articles were manufactured in Poland, including telegraph and telephone apparatus, wireless equipment, cables, lamps, dynamos, motors, switch-gear and household accessories. It is stated that this large increase is due in a great measure to the depreciation of Polish currency, which has rendered it extremely difficult to purchase goods manufactured abroad. Of those which are imported, most are of German and Austrian origin.

Questions and Answers by Practical Men.

RULES.

QUESTIONS : *We invite our readers to send us questions, preferably on technical problems that have arisen in actual practice. Questions which we consider of sufficient interest to our readers will either be replied to under "Answers to Correspondents" or replies will be invited from our readers. One shilling will be paid for the question which we select for competitive replies in this column.*

ANSWERS : *A fee of 10s. will be paid for the answer which we consider shows the greatest merit, and 5s. for the one we select as second best. In judging the replies, importance will be attached to clearness and conciseness, as well as accuracy. The Editor reserves the right to make no award, or to accept only one reply, if, in his opinion, the answers received do not possess sufficient merit. Competitors desiring the return of their manuscripts, if unaccepted, should enclose stamped addressed envelope.*

Write on one side of the paper only, and if diagrams are sent, draw them on a separate sheet of paper attached to the manuscript. Competitors may adopt a "nom de plume," but, both in the case of questions and answers, the competitor's real name and address must be sent with the manuscript as a guarantee of good faith. No correspondence will be entered into with regard to successful replies. The Editor's decision is final.

Commencing with Question No. 101, a Diploma of Merit will be awarded to the six competitors who win the first or second prize the most times during the next twelve months.

The words "Questions and Answers" or "Q" and "A" should be placed at the top left-hand corner of all letters intended for this column.

QUESTION NO. 161.

Are there any hard and fast rules for the earthing of motors? The other day one of my motors, 10 b.h.p., 440 volts D.C. 3-wire, developed an earth. To my surprise, the earth wire, connected from the motor to the conduit, fused. This wire was about $\frac{1}{8}$ in. copper. As this was evidently not strong enough, what wire should be used?—"EXAMINER."

QUESTION NO. 162.

Can any reader give me details of the facts which govern the choice of high-tension insulators? I have heard talk of "Corona effect." What is this? Does it affect insulators used on voltages of over or under 6,600 volts?—"JOINTER."

(*Replies to Questions Nos. 161 and 162 must be received not later than June 30, 1923.*

MAINTENANCE OF TELEPHONE CABLE.*

BY MARK T. CASTER,
Plant Superintendent, Lincoln Telephone and Telegraph Co., Lincoln, Neb.

(*Continued from page 295.*)

LOCATING WET SPOTS.

In locating wet spots choose several pairs (those showing the most pronounced trouble) and connect an equal number of pairs to each binding post of the "high" winding of the fault finder as shown in Fig. 1-*B*. The exploring coil should then be moved along the cable as described for locating grounds. If the insulation is thoroughly wet, no tone will be heard in the receiver beyond the location of the fault; and if the insulation is thoroughly wet, no tone will be heard be only reduced at the location of the fault as in the case of high resistance grounds.

Another method which is sometimes used for locating wet spots is to connect several pairs to one binding post of the fault finder, the sheath of the cable to the other binding post and proceed as in the case of grounds. Beyond the location of the fault "no tone" or "tone" reduced in volume will be heard in the receiver. See Fig. 1-*C* for test connections.

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* *Telephony*, Chicago.

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LOCATING CROSSED PAIRS.

For locating crossed pairs the fault finder should be connected as shown in Fig. 1-*D*. Beyond the fault no tone will be heard in the receiver.

LOCATING SHORT-CIRCUITED PAIRS.

For locating short-circuited pairs the fault finder should be connected as shown in Fig. 1-*E*. If it is known for a certainty that the cross has no appreciable resistance, the "low" coil should be used and the fault may be positively located as there will be no tone in the receiver beyond the fault.

If, however, the fault shows considerable resistance, then the "high" coil must be connected to the conductors in trouble. There may not be any tone in the receiver beyond the fault, but in many cases the tone does not cease beyond the fault, although its volume is reduced. Therefore, much care should be exercised in determining at what point the tone is reduced.

TEMPORARY REPAIRS ON WET CABLES.

The location of the trouble having been determined, the next step is that of making repairs. The man doing the work should provide himself with a helper and such tools from the cable repair kit as will be needed to temporarily repair the cable.

Much care should be exercised in the matter of providing a safe and convenient place to work—safety being the first consideration. In some instances an extension ladder, supported against the messenger and with both sides of the ladder lashed to the messenger with $\frac{5}{8}$-inch or $\frac{1}{2}$-inch rope, provides a suitable place from which to work. In places where a ladder cannot be used, the cableman's platform should be substituted.

In the event a platform is used, it should be securely supported from the messenger by means of ropes, not less than $\frac{3}{4}$-inch, and properly guyed to some pole or other stationary object by ropes of not less than $\frac{1}{2}$-inch in diameter to prevent tipping sidewise.

(To be continued.)

Trade Notes.

A well printed price list of "Zed" Fuses and Distribution Boards, together with a clear and eminently practical description of the "Zed" Fuse System, has just been issued by the **Siemens and English Electric Co., Ltd.**, of 39, Upper Thames St., E.C.4, and branches. The "Zed" fuses are so well and favourably known throughout the world that they do not need any description, but we can cordially advise installation contractors and engineers to make early application for a copy of this new list. List No. 63, which has just been issued by the same company, gives details of the various types of Siemens electric fans, which may be obtained and used for every purpose. Ordinarily, one would associate these fans with a heat wave, and in view of the vagaries of the English climate, we can quite expect that we shall have one with us when these lines appear in print. At the moment of writing one would be far more interested in making use of them to waft a current of warm air through this office, and in view of their well-known efficiency, we have no doubt that many of the customers will use them for such purposes. The list is one which should be in the hands of every trade dealer and contractor.

A new **E.D.A** leaflet is entitled "In Kitchen Cool," and is a capital advertisement of the advantages of cooking by electricity, one of the foremost of which is that by using electric current for this purpose a kitchen can be kept delightfully cool on the hottest summer day. It should prove a useful line for contractors who are anxious to push installation work in this direction during the summer months.

The second number of the "Benjamin Bulletin" has been issued by the **Benjamin Electric, Ltd.**, of Brantwood Works, Tariff Road, London, N. 17. It opens with an editorial of interest to motor agents, referring more particularly to the series of articles which commence in that issue under the heading of "Ask Them to Buy." The circular should most certainly help to increase the turnover of such agents in view of the excellent trade which should arise by stocking Benjamin specialities.

"Incandescent Electric Lamps Handbook No. 1 D" has just come to hand from the **British Thomson-Houston Co., Ltd.**, and will be welcomed by a very large number of trade readers. It is a comprehensive book list of 52 pp. containing prices and general information on Group I. Mazda vacuum and gas-filled and B.T.H. carbon lamps. It should therefore prove of direct value to every electrical installation contractor and factor.

The Foster Engineering Co., Ltd, Morden Works, Wimbledon, S.W.19, have opened a new branch at 19, Barwick St., Birmingham, Mr. L. D. Gunnell, who has represented the company in the Home Counties for some time, having been appointed branch manager. The Foster Co. are not strangers to the district, their agency for Birmingham having been in the hands of Mr. A. Goldie Engholm for many years past. This gentleman ceased to represent them as and from the 1st inst.

Leaflet No. 627 describes the Bencolite Units now being marketed by the **Benjamin Electric, Ltd.**, of Tariff Road, London, N.17. A Bencolite installation will insure light of correct intensity and daylight safety, and it should therefore appeal to installation contractors who may have to submit estimates for the special illumination of offices, workshops, factories, etc.; in fact, wherever the client sets any value on efficient illumination.

A small folder advertising the Cosmos Electric Iron has just been issued by the **Metropolitan Vickers Electrical Co., Ltd.**, of Trafford Park, Manchester. It is intended for distribution to retailers in order to assist their sale, and the neat illustrations showing the various practical applications should undoubtedly help to increase the demand for these useful accessories. The names and addresses of retailers can be overprinted on the circulars, and it is to be hoped that the trade will take full opportunity of this endeavour to assist their interests in a mutual sense.

When contractors and dealers order electrical apparatus and fittings the **E.D.A.** wish them to ask for British Standard Connections. This is a point which should always be borne in mind. It means reliability, and is at the same time good for British trade.

"A Home of a Hundred Comforts" is the title of a well-printed price list which is being issued to the electrical trade by the **Hotpoint Electric Appliance Co., Ltd.**, of 21, Berners Street, London, W.1. It is accompanied by a letter setting forth the contents of the pamphlet and the advantages which can occur to trade dealers by stocking the Hotpoint goods and pushing them with their various clients. We have no doubt that it will be much appreciated, and it should most certainly help to increase the trade in electric cooking and heating appliances, for which the company has gained a high reputation.

From **Messrs. Gourmet and Co.**, of 149A, Junction Road, London, N.19, we have received a price list of Fusol Fluxes, which they claim as being especially suitable for use in the electrical trade. They will be pleased to send a copy of the list to any trade reader on application, and it should most certainly be of direct interest to all installation contractors who purchase soldering material in quantities.

A well-printed list just isued by the **British Insulated and Helsby Cables, Ltd.**, of Prescot, gives illustrations and prices of their latest types of armoured cables and accessories, including cable racks, indoor terminal boxes, insulated unit type pillars, outdoor terminal boxes, service boxes and other accessories, which are of direct technical interest to all central station engineers, to whom the catalogue can be most cordially recommended, and to whom the company will be pleased to send copies on official application.

Literature.—*The Port of Hull Annual for* 1923 (3s. 9d. net, post free) is a large and well illustrated work in which are given the leading particulars about this great port. It contains descriptions of the docks, buildings, factories, shipping facilities, and in fact all possible information which can be of value to British manufacturers who may be considering the question of locating their works near a port from which shipping lines radiate to every part of the world. Mr. Newham, the editor, is to be congratulated on the work which he has put into the annual, and it is to be hoped that the reward of his labour will be represented by a continued growth in the figures of all the various commercial interests which it is desired to promote.

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Reviews of Books, &c.

[Books noticed in this column will be sent from ELECTRICITY *Office to any part of the world, for the published price, plus ten per cent. for postage (minimum 2d.), and orders will be appreciated.]*

ATOMS. By Jean Perrin. Authorised Translation by D. Ll. Hammick, M.A. 231 pages. (Constable, 8s. 6d.) Professor Perrin's book is now a scientific classic to which, as to its literary compeers, we return again and again, while every time we recapture the freshness of the first reading. As with many books that hail from France, the original language is bright and imaginative. So is this English version, except where too literal a rendering results in a flowery variety of "French-English." Remarkably, the data are a just selection, and nothing is over or under-stressed. Even more remarkably, the book presents a philosophy with but the infinities as its limits. Universal discontinuity is this philosophy. It is illustrated by the chemical indications of atoms and molecules, by their "Brownian" movement, from which an extension is made to comparable fluctuations in other systems, by the development of the quantum theory of radiation, and by the atomic nature of electricity and radioactivity, leading to the conclusions of a discontinuous structure of the atom. Within a like compass, no other book presents this philosophy in a manner so convincing yet just, nor conveys so much of importance in so doing. No one of any scientific appreciation can fail to enjoy "Atoms," nor to profit by it.

PROCEEDINGS OF THE INST. OF RY. SIGNAL ENGINEERS, 1922. (Price 10s. 6d. net.) The annual report of this very enterprising institution is a stout 8vo book of 222 pages, as well as a number of folding diagrams, and in addition to a list of members, statement of accounts, business reports, etc., it contains reprints of some remarkably interesting and instructive papers on such subjects as "Signal Repeaters and Light Indicators," "Signal Replacers," "Intermediate Block Signalling," 'Rotary Interlocking Block," "Light Signals," etc., together with the discussions which followed, all of which can be recommended to the careful perusal of any readers who are engaged in railway signal operation and maintenance. The book has been most carefully edited by the Hon. Sec. of the Institution, Mr. M. G. Tweedie, A.M.I.E.E., who contributed the excellent chapter on the use and maintenance of Electrical Railway Signalling and Communication Apparatus in the 1923 edition of the "Practical Electrician's Pocket Book."

A HANDBOOK OF TESTING. Vol. II. The Theory of Prime Movers. By Smith and Warren. Cl. 8vo., 299 pp., 246 figs. (Constable, 22s. 6d. net.)—During the years that the chair of engineering at the University of Hong Kong has been occupied by Prof. C. A. M. Smith, he has not only added largely to its fame as a training centre for British engineers in the Far East, but he has placed the profession under a deep debt of gratitude to him for several really excellent text books, and the volume now before us, in the production of which he has had the able collaboration of Prof. A. G. Warren, who occupies the chair of physics in the same university, will most certainly add to their reputation. It consists chiefly of notes prepared by them for lectures to their students, and the authors claim that they are so worded as to make some of the more difficult problems appear less complicated. With this we agree most cordially. A careful examination of the text and the diagrams with which it is profusely illustrated, leads us to the conclusion that its use should smooth away many of the difficulties with which students are faced in their endeavours to grasp the connection between theory and practice in this subject. It will also help the readers to grasp more readily the intimate association between the lectures in physics and engineering, while many of the notes will be of direct use to any engineer who has not had the advantage of university training. There are many questions based on the worked examples, and the student who uses this book to full advantage will have gained an excellent insight into this particular section of engineering training, which should stand him in good stead in his future career. Our only regret is the price at which the book is published, but that direct handicap on education is due to the outrageous cost of printing technical books in this country, and is in no way the fault of the authors or the publishers, who may be congratulated without hesitation.

SOCIALISM: ITS FALLACIES AND DANGERS. (Watts, 1s. net.)—Messrs. Watts and Co. have just published a fifth and revised edition of this book, which is a collection of papers edited by Mr. Frederick Millar, and already has a wide circulation as a manual of facts and figures showing the utterly fallacious and dangerous character of the theories of Socialism and Communism to which the Labour Party is committed. Several chapters forming part of the previous editions have been omitted and new and important matter substituted, with a view to making the book a comprehensive argument with which completely to refute the pernicious doctrines of the revolutionaries, whose aim is the destruction of civilised society and the erection of a despotism such as that under which Russia has gone to her doom.

TRACTION MOTOR CONTROL. (Direct Current.) By A. T. Dover. (Pitman, 2s. 6d. net.)—This excellent little book should find a ready sale among all readers who are in any way interested in the control of D.C. motors for trains, trams and railless vehicles. The author's larger work on "Electric Motors and Control Systems" is already well and favourably known, and in this small primer he has dealt most ably with D.C. motor control from a more introductory point of view. It is really an elementary exposition of the *principles* which are involved in the subject, and very lucid examples are given of the simpler control systems, as well as the essential features of the more complicated multiple-unit automatic systems. The connection diagrams are wonderfully clear and can be followed without difficulty, and particular attention has been devoted to a discussion of the control systems of electric vehicles. Evidently Mr. Dover is a firm believer in their steady development in this country, and we congratulate him accordingly. Altogether we can recommend the book without hesitation.

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A POPULAR SCIENTIFIC WEEKLY JOURNAL
ELECTRICITY
A PRACTICAL TRADE JOURNAL

JUNE 15, 1923.

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AERIALS AND CRYSTALS.

By C. Sylvester, A.M.I.E.E., A.M.I.Mech.E.

Although a large number of articles have recently been written about the fitting of wireless telephony receiving sets, it is most surprising how these instructions have been ignored or only partially carried out. When in the Birmingham district the other day I heard many complaints concerning the inefficiency of some receiving sets, but, upon investigation, I found the majority of complaints were not justified, the so-called inefficiency being the result of carelessness on the part of the person who installed the apparatus.

One of the chief faults appears to be in the fixing of aerials, and the lead-in from the aerial to the house. In one case I noticed one end of an aerial fixed upon an elaborate insulator which would have been quite suitable for insulating a high-tension voltage of at least 6,000 volts. The other end was merely twisted round a tree in a garden, with a piece of canvas between the wire and the bark.

Considering this aerial, it will be seen that the insulation at one end was more than necessary, yet, at the other end, it was not sufficient. When the person who installed this set fitted the aerial he had probably in mind the old text-book quotation, "Wood is an insulator." Wood may be a good insulator under certain conditions, but it is useless for wireless. The insulation resistance between the top of a tree and earth may be as great as 25,000 ohms, but this is not sufficiently high to guarantee efficient receiving.

Again, the aerial we are discussing was touching at least two leaves of the tree to which it was attached. This is ruinous to good insulation even if the ends of the aerial are perfectly insulated. When a leaf of a tree touches an aerial there is a partial short circuit to earth. The magnitude of this short circuit depends upon atmospheric conditions. That is, if the weather is fine the insulation resistance of the aerial is fairly high. When, however, it is raining or the leaf becomes damp through a deposit of dew such as occurs at night time, then the insulation resistance is very low and the whole receiving system becomes inefficient. One cannot blame the manufacturers of receiving sets for such mistakes.

In another installation I noticed that the leading-in wire from the aerial to the house was defective. The person who fixed this installation evidently thought that a hole bored in the frame of a window, and the bare wire passed through it, would meet the case. It does not meet the case from an insulation resistance point of view by any means. A bare wire passed through a wooden window frame is quite as inefficient as using a tree in a garden as an insulator. The conditions are probably worse, since it is quite possible that the whole of the brickwork in the house is damp, thus affording an easy path to earth. It is no use spending money upon insulators for aerials if the remainder of the installation is neglected.

Going a little further into the subject of aerials, I must say that I noticed the use of a large number of double or twin aerials. These are excellent where space is limited. But, in the majority of cases, I noticed that the spreader between the wires was not sufficiently long. That is, the wires were not sufficiently far apart. The efficient spreader should be at least six feet long. There should, however, be no hard and fast rules laid down concerning the distance they should be apart, since the efficiency of the system is increased if the wires are as far apart as possible.

A word of explanation may be necessary regarding this, since a slight knowledge of ordinary electricity is likely to lead the young broadcatcher astray. With ordinary lighting and power circuits one is taught that if the cross sectional area of a wire is increased, the losses due to heating are decreased, and the system is more efficient. This rule does not follow with the wireless receiving aerial. That is, if a single aerial is used, its efficiency cannot be increased by increasing the cross sectional area of the wire.

It is line area that is necessary with wireless, not cross sectional area. Therefore, if two wires in an aerial are close together, it is almost the same as increasing the cross sectional area, and the line area consequently suffers.

The most important part of a wireless receiving set is, probably, the detector. It is certainly the most sensitive. One would imagine that considerable precautions would be necessary to place as good a detector upon the market as possible. This, however, is not the case, since, in many of the cheaper sets, I have noticed there is considerable room for improvement in the manufacture of detectors.

The type of detector I am referring to is where the crystal is held in position by means of set screws passing through the side of the brass cup.

Now, a crystal, be it galena or carborundum, depends upon its operation by the fact that it is more sensitive to the passage of electricity in one direction than it is in the other. This makes it quite clear that the contact between the cup and crystal should be as good as possible.

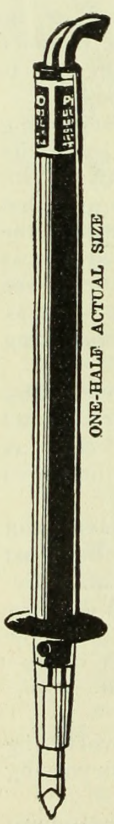
Good contact, or at least permanent contact, is impossible with a set-screw method of fixing the crystal. This is because brass, through atmospheric conditions, must oxidise. Then, when one considers the small point of contact between the end of a set-screw and

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the uneven surface of the crystal, it can be understood that the point of contact must be variable, thus decreasing the efficiency of the detector.

I would strongly advice all broadcatchers who have purchased the type of detector described above to dispose of their set-screws at once. In their place the crystal should be permanently fixed with solder in the cup. This is accomplished at follows:—Tin the inside of the cup with ordinary solder, using resin as a flux. When tinned, fill the cup with small pieces of fuse wire and place a small piece of resin on the top. The set-screw holes may be filled with wood to prevent the fuse wire from running out. Now hold the cup over a gas jet and, when the fuse wire has melted, press the crystal in the molten metal. Now allow to cool and it will be found that the crystal is permanently fixed in position. In this manner the metal completely surrounds the uneven surface of the crystal and excellent contact is assured.

SMALL ELECTRIC SOLDERING IRON FOR FINE WORK.



An electric soldering iron for fine work, said to be the smallest electric soldering tool on the market, is that shown in the accompanying illustration. It is used by many leading American manufacturers and governmental departments and weighs about two ounces. The makers claim that it is particularly suitable for soldering small work such as wireless connections, and gives wonderfully efficient results.

It is supplied with large and small tips, both of which are interchangeable, and composed of german silver. The heating element is of platinum, which is considered the best obtainable and used only in the finest instruments.

The handle is of bakelite, about the size of a fountain pen, and is said to be always cool.

In operation this soldering tool consumes about one-half to three-fourths of an ampere. The cost of operation is about threepence per day, based on continual eight hours' use of electric current. The upkeep of the tool is a minimum.

This electric soldering iron may be used with any current or a 12-volt battery, a series current tap being provided which uses a standard electric light bulb for the resistance.

Complete information may be obtained regarding this soldering iron upon application to the English agents, the Broadway Sales Co., Ltd., 4, Great James Street, London, W.C.1.

"**Faraday House Journal.**"—We have received a copy of the summer term issue of this well-edited and most interesting publication. In addition to the usual data regarding appointments gained by Old Faradians in various parts of the world, there are some interesting articles contributed by members, reviews of books, and details of the works to which various students have been transferred in the course of their studies

MAINTENANCE OF TELEPHONE CABLE.*

By Mark T. Caster,
Plant Superintendent, Lincoln Telephone and Telegraph Co., Lincoln, Neb.

(*Continued from page* 307.)

Removing Lead Sheath of Cable.

The drawings in Fig. 2 illustrate proper operations in removal of sheath.

The lead sheath should be removed with a shipping knife and a pocket knife. Start the operation by making a longitudinal cut in the sheath as shown in

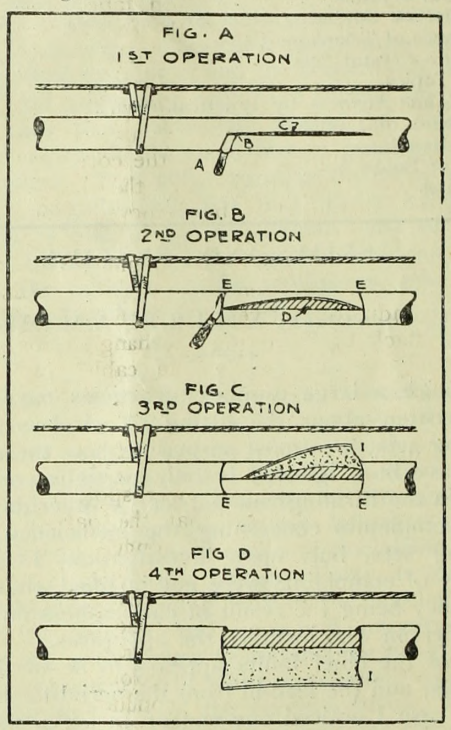


Fig. 2.—Method of Removing Cable Sheath to Repair Conductors.

Fig. 2-*A*. The method of holding the shipping knife for this work is shown at *A*. Blows are struck with a hammer on the head of the knife at *B*, and the knife is given a side motion, which opens the cut in the sheath, as shown at *C*, without the possibility of injuring the insulation or conductors.

The required length of this incision is problematical. To start with, it should not be longer than six or eight inches and should extend equal distances on either side of the crack or opening. Open up the sheath with the claws of the claw hammer as shown at *D*, Fig. 2-*B*, just enough to expose the core so it may be examined for traces of moisture. Water tends to discolour both the inside of the sheath and the paper insulation.

In the event that moisture is detected, the length of this incision should be extended far enough to either side of the crack or hole to get past all visible traces of moisture. The next operation is to cut a circular groove around the sheath at each end of the longitudinal incision as shown at *E*, Fig. 2-*B*.

In doing this a sharp pocket-knife is the best tool to use. Press the edge of the knife against the sheath

* *Telephony*, Chicago.

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in the location of the desired groove, then rock the knife so as to produce the same effect as if the sheath was rolled along the upturned edge of a knife blade. Continue this operation until a groove has been cut the entire distance around the sheath. Care should be taken not to cut a goove deeper than halfway through the sheath.

If the knife cuts entirely through the sheath, a sharp edge will be produced at the inner side and the insulation may also be damaged. The sheath may now be turned back as shown at *I*, Fig 2-*C*, by means of the claw hammer. If properly cut and removed, the inside of the remaining sheath at each end of the incision will be rounded and smooth, Fig. 2-*D*.

Wrap freshly boiled cotton tape, about ¾-inch in width, around the core at the end of the sheath with a thin, dull tool. Work the tape back about ½-inch between the sheath and the paper wrapping of the core to protect the core from injury at the edge of the sheath. The tape should be applied so as to cover the paper wrapping around the core of the cable for about ½-inch from the ends of the sheath. The paper wrapping should then be removed from around the core up to the cotton wrapping.

Next separate the wires enough to allow the fingers to pass freely between them. If the tension on the cable conductor prevents a satisfactory separation, secure slack by removing the hangers for about three or four feet and force the cable away from the messenger in the centre of this section, after which replace the hangers.

Examination of Insulation and Conductors.

Before boiling out the wet spot, an examination should be made to see that the paper insulation is not damaged, and that the conductors have not been corroded off, due to an electro-chemical action which sometimes takes place if the trouble has been of very long duration. Evidence of electro-chemical action will be visible, due to discolouration of the paper insulation, giving it a copper-coloured stain. In cases where defective insulation or conductors are discovered, the conditions should be repaired and an explanation given on the report covering each repair job, as instructed hereinafter.

Open conductors are repaired by splicing in new pieces of core wire. This core wire may be secured from the waste pieces of cable resulting from construction jobs or being carried in the store-room. Wire for this purpose should be boiled out with hot paraffine and properly stored with other cable material.

When open conductors are discovered, be careful to disturb them as little as possible, before the adjacent ends are connected, because of the possibility of getting the conductors mixed and splicing wrong pairs together when both conductors of more than one pair are open. To avoid this, carefuly lift one pair from its place in the layers and repair it before disturbing the next one.

The proper method of joining conductors in a cable is shown in Fig. 3. By following this plan, pieces of properly insulated cable conductors may be substituted for defective sections.

Preparation of Paraffine.

The paraffine should be prepared for use as follows: Place the furnace on a level surface, away from side or cross walks or inflammable articles. The furnace should never be placed within 10 feet of a manhole because of the danger to the workman in the manhole if the pot of paraffine or metal should be accidentally upset.

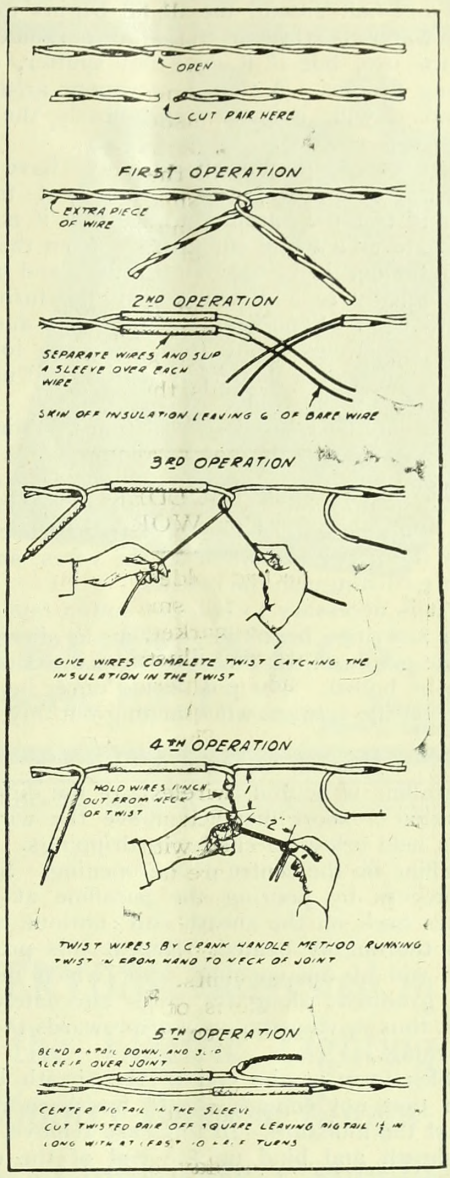


FIG. 3.—METHOD OF REPAIRING OPEN CONDUCTORS.

See that the paraffine pot is filled about two-thirds full with paraffine. If a large pot is used, heat the sides of the pot before placing it on the furnace. This will allow the paraffine to circulate around the sides of the pot and prevent a possible explosion when it is being heated from the bottom. After the paraffine has been melted around the sides of the pot, place it on the furnace and heat it to a temperature of 375 degrees.

In cases where thermometers are furnished, place the thermometer in the paraffine so that the bulb will not touch the bottom or sides of the pot, or the temperature recorded will not be correct. When the themometer registers the proper temperature, remove the pot from the furnace and begin the process of boiling out the cable.

If a thermometer is not provided, determine the

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proper temperature of the paraffine by means of an approved visual test. To the inexperienced men the placing of a few drops of water in the hot paraffine is probably the most reliable test. If, after a pause of about one-half second the liquid begins to sputter and the water is thrown out, the paraffine is hot enough for use, but if it does not sputter, continue the heating process. A thin grey vapour arising from the paraffine will indicate when nearly the proper temperature is reached.

As soon as the paraffine appears to have reached the proper temperature, remove the pot from the furnace and test the paraffine to see that it is *not too hot*. Whenever a white smoke rises from the surface of the paraffine, it is too hot to use, and must be removed quickly to a distance from the furnace and allowed to cool. *Superheated paraffine is dangerous,* as it will sometimes ignite from exposure to the air even when not near a flame. It will also, if used, run the insulation on the cable.

Paraffine may be re-used several times, adding small pieces of paraffine to the pot as required. When the paraffine becomes dirty, *do not attempt to use it* any further, but pour it off, clean the pot, and supply fresh paraffine. Paraffine, if used when extremely discoloured, will stain the paper insulation on the wires, and make it difficult to distinguish the colours.

When it is necessary to boil out cotton tape, muslin or cotton sleeving, heat the paraffine as directed and remove the pot from the furnace before introducing the article to be boiled. The pot should never be allowed to remain on the furnace when boiling-out any splicing materials.

Boiling Out the Cable.

The paraffine is poured by means of the dipper held in a position a short distance above the wires, and the pot is held below to catch the drippings. *Do not pour* paraffine on the centre of the opening. Start the boiling process by pouring the paraffine at a point four inches back on the sheath and continue until the sheath is thoroughly heated. Repeat this process at the other end of the opening, after which move the operation gradually along the wires alternately—from both ends, thus driving the moisture towards the centre of the opening.

If bubbles form at the end of the sheath it is an indication that not enough sheath has been removed to get past the moisture. In this case remove another foot of sheath and bind up the end of the opening with muslin as directed in the foregoing, after which, with the paraffine at proper temperature, pouring should again be started. The pouring should be continued as long as bubbles are given off, or a cracking or frying sound is heard. Moisture must not be driven back into the cable and care must be taken to guard against it by applying the hot paraffine first to the cable sheath at the ends of the opening.

(To be continued.)

Uruguay.—The Department of Overseas Trade have just issued a report on the Economic Conditions in Uruguay to January, 1923. It explains the difficulties which at present face the trade in this country owing to the world-wide depression. British commerce with the Republic shows an improvement for 1921, but is still below 1920, and French and Belgian firms are competing keenly for the market, particularly in electrical goods. It is to be hoped that British export firms will be able to hold their own in this line. The book can be obtained from H.M. Stationery Office, price 1s. 1d., post free, or from Electricity Office.

AERIALS FOR CRYSTAL SETS.

In the current issue of *The Faraday House Journal* there is a reference to our *Practical Electrician's Pocket Book,* which reference contains what is not exactly a criticism, but really an additional statement based upon the remark in our broadcasting chapter that a good aerial is essential with a crystal set. We refer to the following paragraph in *The Faraday House Journal*:—"If, however, the broadcasting station be only a few miles away, we have found that a good crystal set will operate without any aerial at all if the gas-pipes be used as an earth. The gas-pipes sometimes make both an excellent earth and an excellent aerial."

We do not think that the writer of the above paragraph in any way intends to disagree with the advice that we give, but he wishes to point out that within a few miles from a station it is *possible* in some cases to receive the transmissions on a crystal set under the conditions he mentions. To receive under these conditions, one would have to be, as he states, within a few miles from the broadcasting station. Our experience is that the majority of receiving stations are outside the few miles' limit, so that reception on a gas-pipe would hardly be a very distinct success, except, perhaps, in a few isolated cases, which are more or less freak conditions.

In advising readers of our pocket book, we have to take the real practical aspect from a broad point of view, and we say, without hesitation, that, in order to use a crystal set for the real musical pleasure of receiving the broadcast transmissions, a good aerial is essential. In fact, the better the aerial, the better the reception, given the same crystal set.

While we agree that freak conditions are possible, we obviously cannot recommend such conditions generally. Leaving the question of crystal sets, we might have stated that with a valve set it is quite possible, even as far away as 15to 20 miles from a broadcasting station, to receive such a station satisfactorily using the spring mattress of a bed for an aerial. This, again, is what we should call a freak condition.

With regard to the reference to gas-pipes, it is laid down in practically all fire insurance regulations that gas-pipes must *not* be used for electrical earthing purposes, and we should construe this statement also to mean that the gas-pipes must not be used for any electrical purpose.

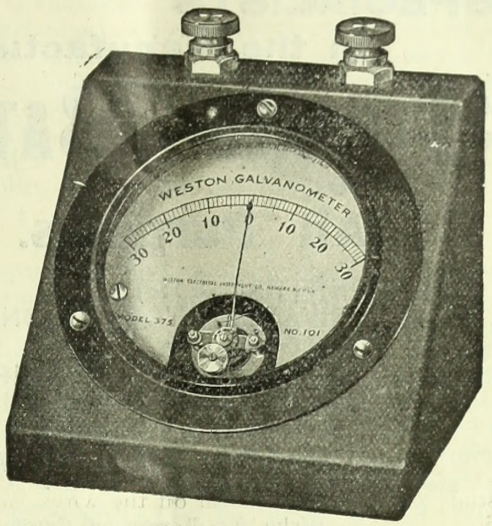
Board of Trade regulations also uphold this point. Therefore, leaving out the question or the possibility or the probability of results using gas-pipe aerials, their use is definitely against the rules, and, should a fire occur on premises where such connections were made, even although not due to such connection, we are afraid that the insurance companies would not allow the claim. The rules laid down by the Institution of Electrical Engineers also condemn the use of gas-pipes (see para. 28, I.E.E. Rules).

East Midlands.—The Electricity Commissioners announce that they intend to hold a local inquiry at the Guildhall, Nottingham, on Tuesday, July 10, at 10.30 a.m., with reference to the scheme which has been promoted under this heading for certain parts of the counties of Derby, Leicester, Nottingham and Stafford. Copies of the draft scheme may be obtained from the secretary at Gwydyr House, Whitehall, London, S.W.1.

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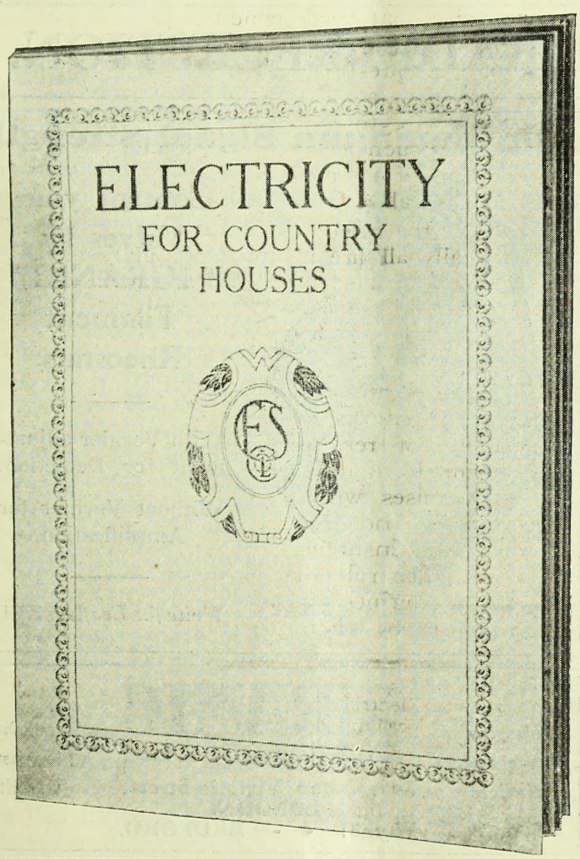
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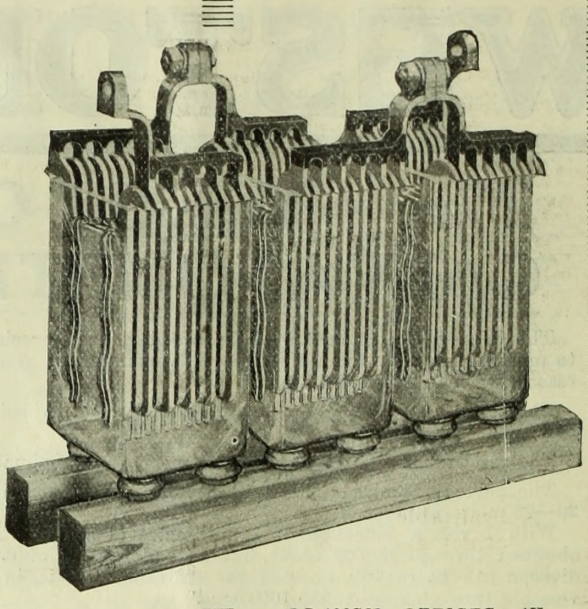
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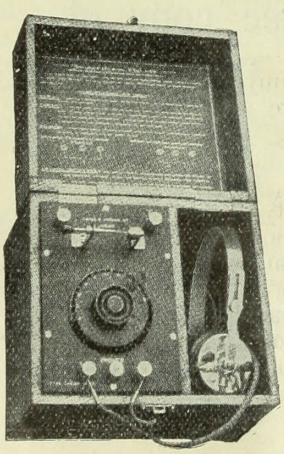
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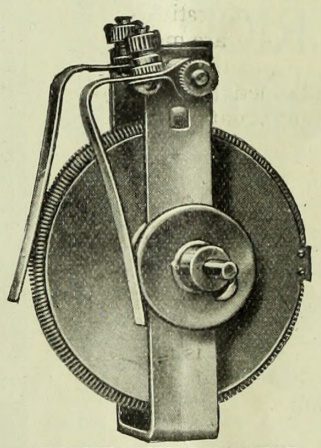
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TO OUR READERS.

ELECTRICITY is published every Friday, and, if ordered, is on sale at the principal Railway Station Bookstalls and Newsagents on that day. It has a very large sale throughout the United Kingdom, as well as in the British Colonies and Abroad.

New advertisements for the displayed columns and alterations to existing ones must reach the publishing office not later than first post Tuesday morning, in order to be in time for the issue of the following Friday. This is important. Rate quoted on application. Subscription: 13s. a year, 6s. 6d. half year, 3s. 3d. a quarter in advance, postage prepaid in the United Kingdom and abroad.

Questions to which an answer is required must be accompanied by a 1½d. stamp for reply. When considered of sufficient interest, the answer will probably appear in the paper.

All remittances payable to the Publishers, S. RENTELL AND CO., LTD., 36 39, Maiden Lane, London, W.C.2. Telephone No. 2460 Gerrard.

Current Topics.

A Profitable Continental Visit.

Always provided the visiting committee is limited to those officials actively interested, and that there is no suggestion of a joy ride at the ratepayers' expense, there is much to be said in favour of such a visit of inspection as that recently paid by a small body of councillors, representing the Nottingham Corporation Electricity Committee, to Paris in order to study at first hand the new French super-power stations which are in course of construction. The party, which included the chairman of the Committee, Mr. J. H. Rider, who is responsible for the plans of the projected Nottingham scheme, Mr. H. Talbot, the Corporation Electrical Engineer, and Mr. T. W. Gordon, the City Engineer, visited the Gennevilliers power station, which is eight miles north of Paris, and although only partially completed, already accommodates from eight to ten generators, each of 40,000 kw., and constitutes the largest station of its kind in Europe.

The party also visited the Paris generating station at St. Ouen, and were shown the remarkably efficient and up-to-date coal and ash-handling plant which deals with some eighty tons of material per day, and makes very effective use of a comparatively low grade of coal, whilst the ash and refuse are mechanically washed and screened, to be subsequently used in the manufacture of bricks. It is claimed by the sponsors of the trip that much valuable information and data have been secured as a result, and that advantage will be taken of the collated information in securing maximum efficiency and the very latest practices in connection with the Nottingham scheme now under consideration. In view of the fact that representative councillors of our larger cities have seldom had the opportunity of acquiring first-hand information and experience of such gigantic schemes as those upon which they are now required to legislate, there is much to be said in commendation of the system of inspection thus inaugurated at Nottingham.

Automatic Telephone Development.

The *Daily Mail* having displayed such active interest in the early fostering of automatic telephony for public service in this country, it is the more surprising to note a recent paragraph in that journal which would appear to indicate that their technical reporters are no longer abreast of the times in regard to the facts concerning automatic telephone development. In referring to automatic telephone tests now being conducted by the General Post Office at their research station at Dollis Hill, the writer conveys the impression that there is a multiplicity of systems, none of which are yet perfected, and that the department is still busily engaged in developing a satisfactory system for use in this country. Fleetwood is referred to as having the latest system, whilst that at Leeds,, the largest automatic telephone exchange at present in this country, and in fact, in Europe, is dubbed an older system, and credited with 6,000 lines only, whereas the actual total is now nearer 10,000. The automatic telephoning of London, also, is referred to in a future tense, and as indicating a vast problem which has not yet been satisfactorily solved.

As a matter of fact, although there are admittedly several systems of automatic telephony on trial in this country, there is only one which is a firmly established commercial success and has already been adapted to the successful inter-switching of well over a million lines in the United States, South America, Australia, India, Mesopotamia, Manchuria, and other equally remote districts. The Strowger system, originally invented by an undertaker of that name, has now been in active operation for well over a quarter of a century, and has long since proved its praticability for cities of the largest dimensions, equally with the requirements of small and insignificant private exchanges for inter-departmental telephoning. It is the Strowger system which has been adopted in the majority of existing British exchanges so far converted, and is equally adaptable to the more complex requirements of such a metropolis as London or New York.

The sponsors of the original Strowger system of automatic telephony number a majority of the most efficient automatic telephone engineers either in this country or the United States. Constant developments are taking place on both sides of the Atlantic, and those engineers have yet to be confronted with a commercial telephone problem which they are incapable of solving with the apparatus and equipment already available. Given a sufficiently progressive policy on the part of our telephone administrators, it is safe to predict that in another ten years Strowger automatic telephony will predominate over the present manual service which it is now so rapidly displacing.

Reciprocity.

A rather curious side-light on the mutual interdependence of coal and electrical energy was revealed by Professor Douglas Hay, of Sheffield University, in the course of a lecture on "Recent Electrical Developments in Coal Mining," delivered at the International Mining Exhibition at the Agricultural Hall. According to Professor Hay, if we were suddenly to lose the service of electricity in our collieries, coal would cost us very much more. So rapid has been this development that the coal mining industry is now almost entirely dependent upon electricity as a source of power for the successful and economic winning of our coal seams; without it many mines could not be operated, and others could not produce at an economic cost. This little appreciated fact is the more remarkable when we come to consider for a moment the reverse side of the picture and realise how absolutely dependent the electricity supply industry is upon a cheap and

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abundant coal supply. Both industries are mutually and indissolubly interlinked and could not exist apart, however much they have been able to do so in the past, when the demand for both products had not attained to present-day dimensions.

A Chance for Distinction.

Once again, as is customary at this period, the secretary of the Institution of Electrical Engineers issues his appeal for papers on subjects of interest to the electrical industry. These papers may be suitable for discussion at ordinary metings or for publication in the Institution Journal without being read at a meeting. All papers accepted by the Council for publication, and printed in the Journal are eligible for premiums, whether read and discused at a meeting or not. As there are now no less than eleven premiums or awards for excellence in particular branches, as well as for papers on general electrical subjects, there is every inducement to ambitious members and associates to submit appropriate contributions.

There is no better way of achieving a reputation in the profession or demonstrating one's outstanding knowledge or ability in any given branch of electrical industry than through the medium of a successful Institution paper. Publications in the Journal which have outstanding merit or qualify for a premium, are generally regarded as classics on the subject dealt with, and their authors are accepted as leading authorities in the particular subjects of the papers. Apart from this aspect of the question of contributing to the general interest, it should be the aim of every member, associate and student, to do his bit towards making the Institution thoroughly representative of the profession for which it stands. Mere membership and the payment of an annual subscription does not constitute the full duty of those who belong to this body, and if every subscriber made a point of contributing at least one essay on a pet subject during his term of membership, the meetings and the Journal would materially benefit, whilst the Institution as a body would be greatly assisted in the achievement of its avowed objects.

ELEKTRON.

Unemployment Books.—The Minister of Labour desires to call the attention of employers and insured contributors to the fact that their Unemployment Books for 1922-23 cease to be current on July 1, 1923, and must be exchanged for new books during the week ending July 7, 1923. Employers should communicate immediately with the nearest Employment Exchange or Branch Employment Office of the Ministry of Labour, if they have not already done so, respecting the special facilities available in this connection.

New Zealand.—An important proposition is now before the Hutt Valley Power Board in connection with the installation of an electric distribution system in the district. It has been approved by a large majority of the ratepayers, the idea being to raise a loan of £200,000 and to obtain power to the ultimate extent of 2,000 k.v.a. from the hydro electric station at Mangahao. The money would be laid out in extra high-tension lines sub-stations and distribution generally. Messrs. Templin and Toogood, hydro electrical engineers, of 11, Gray Street, Wellington, N.Z., have been appointed consulting engineers to the Board, and fuller particulars may be obtained from the Department of Overseas Trade, 35, Old Queen Street, London, S.W.1. It should mean important orders for English electrical engineering firms.

Questions and Answers by Practical Men.

RULES.

QUESTIONS: *We invite our readers to send us questions, preferably on technical problems that have arisen in actual practice. Questions which we consider of sufficient interest to our readers will either be replied to under "Answers to Correspondents" or replies will be invited from our readers. One shilling will be paid for the question which we select for competitive replies in this column.*

ANSWERS: *A fee of 10s. will be paid for the answer which we consider shows the greatest merit, and 5s. for the one we select as second best. In judging the replies, importance will be attached to clearness and conciseness, as well as accuracy. The Editor reserves the right to make no award, or to accept only one reply, if, in his opinion, the answers received do not possess sufficient merit. Competitors desiring the return of their manuscripts, if unaccepted, should enclose stamped addressed envelope.*

Write on one side of the paper only, and if diagrams are sent, draw them on a separate sheet of paper attached to the manuscript. Competitors may adopt a "nom de plume," but, both in the case of questions and answers, the competitor's real name and address must be sent with the manuscript as a guarantee of good faith. No correspondence will be entered into with regard to successful replies. The Editor's decision is final.

Commencing with Question No. 101, a Diploma of Merit will be awarded to the six competitors who win the first or second prize the most times during the next twelve months.

The words "Questions and Answers" or "Q" and "A" should be placed at the top left-hand corner of all letters intended for this column.

QUESTION NO. 161.

Are there any hard and fast rules for the earthing of motors? The other day one of my motors, 10 b.h.p., 440 volts D.C. 3-wire, developed an earth. To my surprise, the earth wire, connected from the motor to the conduit, fused. This wire was about ⅛ in. copper. As this was evidently not strong enough, what wire should be used?—"EXAMINER."

QUESTION NO. 162.

Can any reader give me details of the facts which govern the choice of high-tension insulators? I have heard talk of "Corona effect." What is this? Does it affect insulators used on voltages of over or under 6,600 volts?—"JOINTER."

(*Replies to Questions Nos. 161 and 162 must be received not later than June 30, 1923.*

Answers to Questions.

QUESTION NO. 157.

Can any reader give me details from which I can make a Nodon Valve to enable me to charge accumulators from an A.C. supply? What is the action of such a valve?—"WIRELESS."

ANSWERS TO QUESTION NO. 157.

The first prize (10s). has been awarded to S. J. Berryman, Gustavus Road, Camborne, Cornwall, for the following reply:—

The Nodon valve is an electrolytic rectifier in which the cathode is an aluminium alloy rod held centrally in a vessel made of lead, which forms the anode and contains the electrolyte, this being a concentrated solution of ammonium sulphate. Only a short portion at the lower end of the cathode is utilised, the rest, which is rather smaller in diameter, being protected from action by an enclosing glass sleeve. The density of the current at the cathode ranges from 5 to 10 amps. per sq. cm. In large sizes the cells are made double, and a current of air is kept circulating between the walls by means of a motor-driven fan.

The maximum efficiency is obtained at about 140 volts, and the efficiency lies between 65 and 75 per cent. and is practically independent of the frequency between the limits of 25 and 200 cycles.

Above a pressure of 140 volts the efficiency falls off very rapidly owing to breakdown of the film. The power factor is high, being over 90 per cent. at full

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load. The valve is influenced a great deal by the temperature and should not exceed 50 deg. C. In order to utilise both halves of the supply wave, the Gratz method of connection is used (Fig. 4).

The plan and elevation of a 5 amp Nodon valve is shown in Figs. 1 and 2.

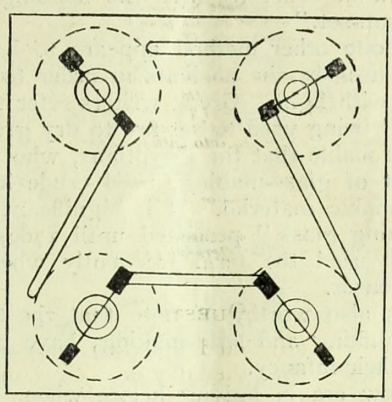


FIG. 1.

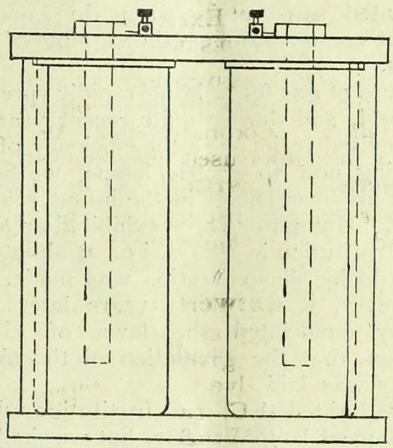


FIG. 2.

In Fig. 3 we have an oscillograph record of the original supply voltage and the corresponding pulsating current at the Nodon valve terminals.

The Gratz method of rectifying current is shown in Fig. 4. This method consists of employing four electrolytic rectifiers per phase, coupled so that both halves of the supply wave are utilised. In Fig. 4 the arrangement shows the four cells in a single-phase rectifier, C1, C2, C3 and C4 are the four rectifier cells. They are coupled in such a manner that the two left-hand cells are in series and are connected in parallel (but with poles opposed) to the two right-hand cells, which are also in series. The alternating current is fed in at the centre points E F of each of the pair of cells, and the pulsating unidirectional current is drawn from the junction C D of the parallel arrangement. Consider a current leaving the transformer by the terminal A at some instant; since the cell will only allow curent to pass from lead to aluminium, the current will pass through C2, then through the load and back to terminal B by way of C3. An instant later the current has reversed and leaves the terminal B of the transformer, traverses C1, then the external circuit in the same direction as before and returns to terminal A through C4.

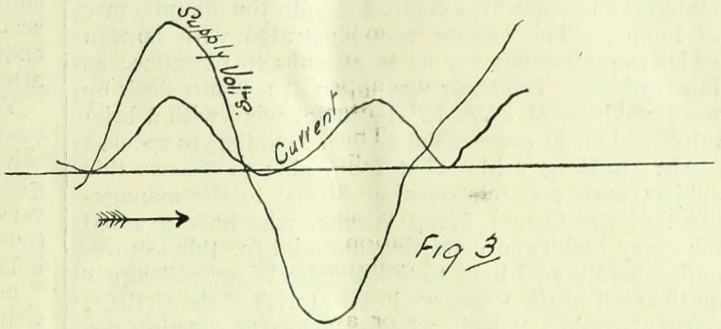


Fig 3

Oscillograph Record of Nodon Valve.

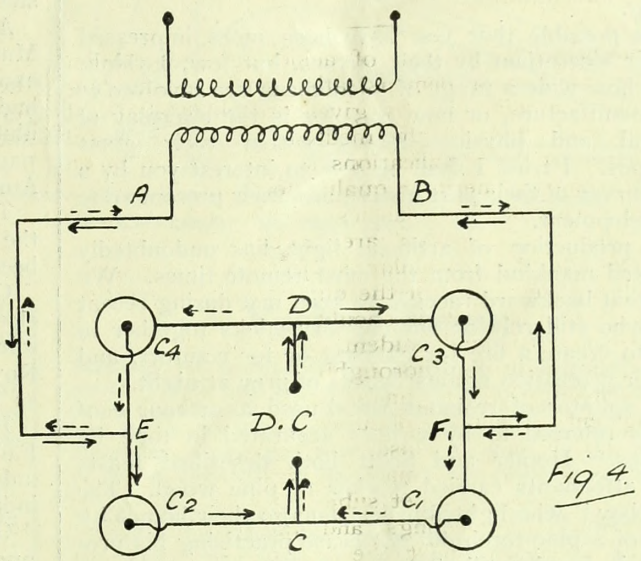


Fig 4.

Gratz Method of Rectifying Current

The direction of the current through the external load is therefore always the same, but varies between zero and its maximum value with twice the frequency of the supply.—S. J. BERRYMAN.

The Second Prize Winner's reply will be published in due course.

Finance.—The annual report of the Rangoon Electric Tramway and Supply Co., Ltd., for the year 1922, shows a gross profit of nearly £130,000, and after deducting debenture interest, depreciation, income tax, etc., and making ample allowances for reserve, there is a balance which will enable the payment of a satisfactory dividend on the ordinary shares and leave a sum of over £18,000 to be carried forward.

Chloride Hospitality.—During the recent conference and summer outing which has been held by the I.E.E. in Manchester and Liverpool, a visit was made to the works of the Chloride Electrical Storage Co., Ltd., the party being conveyed thereto by coaches supplied by the Lancashire United Tramways, Ltd., of Atherton, and we have been favoured with a photograph showing the party enjoying themselves on the lawn outside the Chloride works. From its appearance they seem to have had a very good time.

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MANUFACTURE OF LAMPS.*

This lecture, given in the Library at St. Bride's, attracted a good attendance, but the considerable trouble which the lecturer had evidently taken deserved considerably more. There was an extensive display of material and apparatus connected with the manufacture of lamps. The lecture was illustrated with lantern slides too numerous for us to attempt to reproduce as illustrations. The chair was taken at seven o'clock by the President, Mr. W. E. Highfield, who, with a brief introduction, at once called on Mr. Dudding to speak.

Mr. Dudding said: That I am able to discuss this subject with you this evening is due to the management of the Osram Lamp Works, who have granted me every facility in collecting material for this lecture, and, in addition, I have to thank many of my colleagues on the staff of the Research Laboratories of the G.E.C., particularly Mr. Winch, who has helped in erecting the apparatus which is on view.

You are, no doubt, all very familiar with the commonplace articles which are to claim our attention this evening.

It is possible that you have been more impressed by their vices than by their virtues, but few, I think, realise how wide a range of phenomena are involved in their manufacture, or how complex is the interplay of chemical and physical forces within their glass envelopes. I trust I shall be able to interest you by a short survey of their past history and their present state of development.

The production of artificial light has undoubtedly interested mankind from the most remote times. We know that backward races have been met during recent years who still rely on rubbing dry sticks together in order to create a fire for cooking or for comfort, and light for protection against beasts of prey at night.

The splinter of resinous wood used as a source of light is referred to by writers separated in time by centuries. Homer and Scott both described feasts where attendants carried torches of pine wood. The "link boy" who lighted pedestrians to their homes by means of a pine torch did not cease practising his profession in London till 1840.

As primitive man made tools of stone he could scarcely avoid noticing that sparks were readily formed when certain kinds of stone were struck together, and it is certain he used these sparks to ignite dry grasses etc.

Tinder boxes exist in our museums belonging to bygone ages, and the modern petrol pipe-lighter is a direct descendant of this method of deriving artificial light.

Again, crude lamps were made from stone, and later from glass and metal, in which reeds and grasses served as wicks and vegetable and animal oils as fuel. Lamps may be seen in the British Museum which were probably fashioned some 5,000 years ago.

It does not require a powerful imagination to realise the noxious odour and smoke associated with these early efforts of man to provide himself with artificial light.

No marked improvement was made in oil-burning lamps until Argand introduced the tubular wick and glass chimney in 1784. The next advance was the introduction of the use of mineral oil about 1850. Similarly slow progress marked the evolution of the candle. It has been associated with religious ceremonies from about 1,000 to 2,000 years B.C. It is within the lifetime of present-day people that the plated wick was introduced in order to avoid snuffing. Even now, the odour of some modern candles serves to remind us of the discomfort our forefathers endured in order to have the blessing of "sun-rise after sun-set."

Yet one other method appears to have been commonly used by the ancients in order to provide themselves with light. Greek writers refer to a "burning glass" being used to set fire to dry grasses, and it is very probable that the Egyptians, who were skilled in the art of glass-making, used crude lenses to ignite inflammable material. It is significant that the term "burning glass" persisted until 1700, when science writers used the term frequently when referring to glass lenses.

It is also worthy of note that the two industries, glass-making and light-making, have been associated since their infancy.

A new era in lighing began when, in 1802, Wm. Murdoch, at a meeting of the Royal Society, described experiments on the production of coal gas by which he had illuminated his own home in 1792. In 1802 he illuminated some public signs in London, during a pageant commemorating the signing of the Treaty of Amiens.

The use of gas for lighting rapidly spread throughout the world, and during quite recent years means have been devised to increase the efficiency of gas lamps.

Coming now to electric lamps, we find that feeble electric arcs were made in the infant years of electrical science. Humphrey Davy exhibited an arc lamp at the Royal Institution in 1801-2, i.e., at about the same time as Murdoch's demonstration was made.

However, it was thirty years later when Michael Faraday enunciated the laws of electro-magnetic induction, that the foundation of the electric lighting industry was laid.

Grove lighted the Royal Institution with some platinum filament lamps in 1847, but we shall see later that these lamps were not very efficient. A very marked step forward was made when Edison, in America, and Swan and Stearn, in England, successfully produced a carbon filament incandescent vacuum lamp in 1879-90.

The Nernst oxide filament, introduced in 1897, was the first step towards the production of a more efficient electric incandescent lamp.

In 1903, tantalum, a metal discovered in 1803, was successfully made into filaments, and this resulted in still more efficient production of light.

This improvement was followed rapidly by others. Osmium filament lamps were made in 1905 (experimental lamps appear to have been made in 1898), and tungsten filament lamps in 1906. The next step was the introduction of the gasfilled tungsten filament lamp in 1913, arising out of a research by Dr. Irving Langmuir into the laws governing the transference of heat from a solid to a gas.

This remarkably rapid development was inspired by the recognition of definite laws of physics, which we will now consider briefly in order to appreciate both the development of the electric lamp and the limitations of our present-day lamps.

* Paper read by Bernard P. Dudding, Esq., before the National Association of Supervising Electricians.

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I ask the indulgence of those familiar with the phenomenon of radiation while I briefly recall what is necessary to a clear understanding of what is to follow. Radiation is known under a variety of names, but the only difference is one of frequency of the electro-magnetic disturbance which gives rise to the radiation. Thus, X-rays are very high frequency radiation; wireless telegraphy uses low frequency radiation, whilst heat and light are intermediate.

Light is the name given to the radiation to which the eye responds.

Now, heated bodies radiate energy over a wide range of frequency, but the eye is sensitive to quite a small range.

This is illustrated in Fig. 1, where the wave-length (the inverse of frequency) is plotted horizontally and the quantity of energy radiated within a narrow band of wave-lengths is plotted vertically.

The area of the curve represents total energy radiated. You will notice—

(1) How small a proportion of the energy affects the eye and can produce the sensation of vision, particularly at the lower temperatures.

(2) How rapidly the total energy increases with rise in temperature.

(3) How the energy of short wave-length radiation increases more rapidly than that of long.

(4) How the radio of energy in visible spectrum to the total increases with rise of temperature and considering visible spectrum only.

The recognition of the last of these facts was that which inspired the search for materials which can be maintained at high temperatures without undue deterioration.

The above simple relationships are made more complex by some materials exhibiting power to radiate selectively, but it is not possible or necessary to consider this phenomenon to-night.

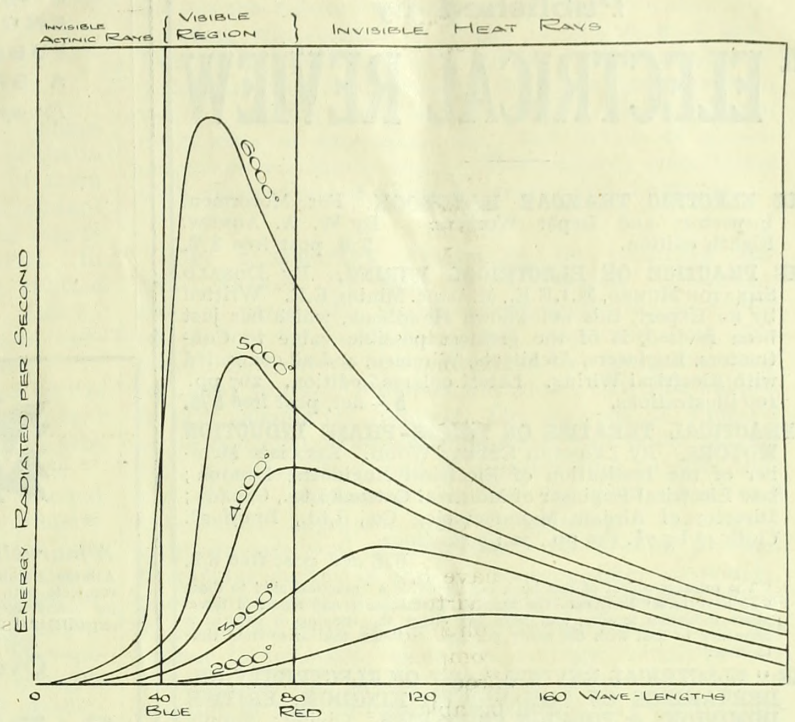
Using any one substance as a filament material, we can see, therefore, that the maximum efficiency is fixed by the maximum temperature at which the filament can be operated without evaporation causing too early deterioration.

In this connection, it is interesting to note that the melting points of tungsten and carbon are not very different, carbon being slightly the higher. But carbon evaporates more readily than tungsten, so that it is not possible to operate it at such a high temperature when used as a filament.

The natural question to ask is: How can evaporation be prevented or retarted?

(To be continued.)

FIG. 1



Energy Curves for Spectra Obtained from Sources at Different Temperatures

Good Luck.—Congratulations to Mr. J. B. Taltaval, the owner of our contemporary, *The Telegraph and Telephone Age*, of New York, on the completion of forty years of successful journalism. Every issue of the paper since it was established on June 1, 1883, has been produced by him, and he has every reason to be proud of his record. The paper has a splendid sale among telegraph and telephone employees, not only in the United States but also in most other countries of the globe.

Various Items.

Meetings.—A meeting of the Institution of Engineering Inspection will be held at the Royal Society of Arts, John Street, Adelphi, London, W.C.2, on Wednesday, July 18, at 7.30 p.m., when Mr. R. P. Wilson, M.I.E.E., will read a paper entitled "Molecules, Atoms and Electrons." Members of the I.E.E. and others interested in the subject are cordially invited to attend.

G.E.C. Studio Arc Lamps.—We expect that the majority of our readers have seen the photographs of the royal wedding group which were taken at Buckingham Palace on April 26 on the occasion of the wedding of H.R.H. the Duke of York. These photographs, which came out so remarkably clear, were obtained under the light of G.E.C. Studio Arc Lamps, and the photographers, Messrs. Elliott and Fry, Ltd., state that they gave every satisfaction.

Presentation.—On the 2nd inst. Mr. Hird, the general manager of Siemens Brothers and Co., Ltd., presented Mr. R. H. Peet, in commemoration of his jubilee with the company, with a gold watch bearing the following inscription:—"Presented to Reginald H. Peet, Esq., by his colleagues as a mark of appreciation on completing his fiftieth year on the staff of Siemens Brothers and Co., Ltd. March, 1923." This mark of friendly feeling and good fellowship on the part of his colleagues was much appreciated by the recipient. The directors of the company supplemented this handsome gift by a substantial cheque.

The Batti Wallah's Society.—We are pleased to hear from Mr. Whitgift, the energetic secretary of this society, that it is going to be revived, and, as far as possible, brought up again to its full pre-war strength. An excellent programme is being prepared for the forthcoming summer, including a summer outing, and a riverside garden fete in August, a visit to the first motor-boat racing and regatta above the Thames on June 30, and a visit to a new super-liner in the late autumn. Full particulars can be obtained from Mr. Whitgift at 7, Coulter Road, London, W.6, and he cordially invites applications from interested readers. Mr. Edgar Barralet is the president for the new session, with M. A. J. Greenly as vice-president.

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Reviews of Books, &c.

[Books noticed in this column will be sent from ELECTRICITY *Office to any part of the world, for the published price, plus ten per cent. for postage (minimum 2d.), and orders will be appreciated.]*

WORKSHOP ROUTINE. By W. J. Hiscox. (Chapman and Hall. 9s. 6d. net.)—There are many books in existence dealing with works systems, many of them written from the point of view rather of the accountant than that of the works manager The practical side is in consequence to a very great extent lost count of. In this book of Mr. Hiscox's we have workshop routine discussed with special reference to standing instructions, and the result is a work that should be of considerable value and use, particularly to engineers.

The writer's grip of the subject is emphasised by the remark that the staff should be the most productive part of the organisation. Providing the staff is properly selected and handled this remark is very true.

As an instance of organisation generally it is cited how that the war changed the whole aspect of industry and forced re-organisation in order to cater for new conditions, and that even the most brilliant pre-war organisers had difficulty in handling such conditions. One of the great troubles in industrial circles to-day appears to be that war-trained organisers are attempting to use the same systems to-day as were brought into being during those recent years of forced production. Such systems, as many firms know to their sorrow, cannot be continued at the present time, and executive members of the staff of such firms are recommended to read Mr. Hiscox's book, as without doubt they will find in it many valuable pointers that will help them to modify an unwieldy system and assist them in efficient management.

All works departments are dealt with, and the co-ordinated methods suggested will prevent what is only too general in factories, and that is, the various departments working in more or less water-tight compartments, not knowing or perhaps caring how other departments work, which of necessity means lack of unity throughout the factory.

Mr. Hiscox's book is one of the few on the subject that we can without hesitation recommend.

INDUSTRIAL ELECTRIC HEATING. By J. W. Beauchamp. 118 pp., 42 figs., 7 tables. (Pitman, 2s. 6d.)—The extremely valuable series of Pitman's primers has gained much by the addition of this work, which is admirably conceived to stimulate the interest of contractors, supply engineers, works and production engineers in the possibilities of applying electricity to heating processes where the value of the product is such as to make ordinary considerations of cost subsidiary. Needless to say, the efficiency, adaptability, flexibility and hygienic value of electrical heating for industrial processes are carefully brought out. The wide field in which electricity as a heating medium is now in general use is concisely covered, particularly important being the excellent chapter on electrically heated tools and appliances, as there is room here for much greater use of electricity than is made at present. Other more specialised chapters are devoted to ovens and muffles, the melting of metals, welding, canteen cookery, baking, etc. To make the book complete for those it is particularly intended to reach, we might add that information is given on the general methods of converting electricity into heat, on installation work, and on the nature and problems of economical supply, including the storage of energy in the form of heat. There is a useful appendix on the conversion of temperatures, the heat required to raise temperatures, various melting and boiling points, specific heats, coefficients of expansion, etc., and details of nickel-chromium resistance wires. The whole is embellished with illustrations of actual apparatus and diagrams.

THE ELEMENTARY PRINCIPLES OF LIGHTING AND PHOTOMETRY. By John W. T. Walsh. (Methuen. 10s. 6d. net.)—Mr. Walsh is well known as an expert on photometry, and has been associated with this branch of the work of the National Physical Laboratory for many years. One finds, therefore, that this subject is very adequately treated. The account of methods of measuring candle-power, working out polar curves, etc., is informative, and it is interesting to note that the sphere photometer is now regarded as a well established apparatus for determining "average" or mean spherical candle-power. In view of the fact that polar curves of modern sources differ so widely, photometric measurements of candle-power at a single angle are of little value. The course preferred by the author is to state values in average candle-power. Older treatises usually confined themselves to an account of the chief forms of photometers used in the laboratory. Readers of this work will discover that the measurement of illumination *in situ* has become quite a familiar process, and a variety of instruments for this purpose are illustrated. Mr. Walsh also shows how illumination can be predicted by simple means when the characteristics of the lighting units are known, and gives some useful rules for the spacing of illuminants. These and similar matters are dealt with in the earlier chapters (I.-V.). The remainder of the book is devoted mainly to practical lighting problems, and this is naturally the portion which will make the widest appeal. Much of the matter is quite readable, in spite of the somewhat formidable title. The advice on the lighting of schools, offices, factories, etc., is sound and easily followed, and one receives the impression that, as a result of the discussions of the Illuminating Engineering Society, the principles of good lighting are becoming clearly crystallised. At the same time, the subject matter covers a very wide field. The remarks on the lighting of various classes of factories are specially helpful; it cannot be too strongly emphasised that such cases cannot be treated in a rule-of-thumb manner. Each industry presents lighting problems of its own. Amongst other miscellaneous matters dealt with may be mentioned the lighting of mines, the testing of searchlights, the design of motor-car headlights and applications of coloured light. The final chapter on "Light Projection" is perhaps one of the most interesting in the book. There is a useful list of references, and an appendix containing official definitions of quantities used in illuminating engineering at the end of the book. The printing and paper are good, and there are many well-executed illustrations. While we imagine that the book will be of special use to students, there is much in it to interest the general reader, and it gives an excellent survey of the wide range of subjects now included under the term "illuminating engineering."

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GEORGE LAVINGTON. By John Harlock. 440 pp., 8vo. (Stockwell, 7s. 6d.)—So true to life are the characters in this fascinating story founded on the introduction of electric lighting into the West of England in the pioneering days that we not only recognise them all, but can visualise them and even feel their presence. This feature is perhaps the one which strikes us the most forcibly, though, except for a pardonable looseness of expression on electrical matters on a few occasions, the actual difficulties which were, and to some extent still are, experienced in connection with the establishment and development of electric service are truly set forth. Experienced business men are well acquainted with the sharp practice still so often practised to hinder trade rivals, the obstruction to progress by vested interests, the pigheadedness of local authorities, the harm which can be done by the black sheep of the Press, the large proportion of knaves to honest, upright men, and the uncertainties of the course events will take in a Court of law, especially where counsel are not equally learned in the loop holes in the law, that to them there may be little which they do not know. To the vast majority of toilers, however, the information in this interesting story should prove of value as enabling them to avoid the pitfalls which beset the path of the progressive but more inexperienced. The electrical matters in the book should prove as interesting to the lay as to the electrical reader, and they form only a part of the subject matter, the hero, George Lavington, being a young man who had to fight his own way up from childhood and makes good in the boot and shoe business. He becomes interested in electrical matters and eventually becomes the dominating force in securing the benefits of electricity for the inhabitants of a large country town. He is, however, ruined in the process. He marries a young girl who seems to be really in love with him. Though in his own way he is in love with her, he is too wrapped in business and does not confide at all in her. When the crash comes she decides to leave him, but at the last, when he is taken ill, she stays and saves his life. The love interest is the weakest part of the book, which would be better if the first 100 pages or so were condensed. The author writes in a peculiarly simple style and shows that he is most observant of detail.

Trade Notes.

The June issue of the monthly trade price list which is issued by the **Siemens and English Electric Lamp Co., Ltd.**, gives details of a very large number of standard accessories which are required by factors and installation contractors generally, and it should therefore be obtained without delay by any trade firm who has not yet received a copy. It will be sent regularly on receipt of proper trade application.

An interesting leaflet, quoting details and prices of M.W. Portable Battery Charging Sets, has just been issued by **Mr. M. W. Woods**, 13/15, Railway Approach, London, S.E.1. It gives full particulars of these sets for charging accumulators direct from electric supply mains, and they are claimed to be very efficient. The list should therefore appeal to a very large number of our readers. It will be forwarded free on application.

Shenton and Co., Ltd., of 68/69, Shoe Lane, E.C.4, have just issued their new net trade list of electrical accessories. This has now been alphabetically arranged in order to enable customers to pick out immediately the lines of which they require prices, and it should therefore prove of use to all electrical contractors for quick reference purposes. It will be sent on the usual trade application asking for List 623.

Messrs. Stilwell and Sons, name plate makers, of 7, Jordan Well, Coventry, are issuing leaflets illustrating a few of the many types of name and instruction plates which they manufacture for the electrical and allied trades. These goods should be of direct interest to every manufacturer of, or dealer in, wireless supplies and kindred appliances, and Messrs. Stilwell invite inquiries. Their advert. will be found in our prepaid pages.

Manufacturers of wireless supplies and others who wish to purchase wireless cabinets will be interested in the advert. of **Messrs. Pickett Bros.**, cabinet makers, of Albion Road, Pincott Road, Bexley Heath, S.E., which appears in our prepaid columns. They invite inquiries, and are prepared to quote low prices combined with good material.

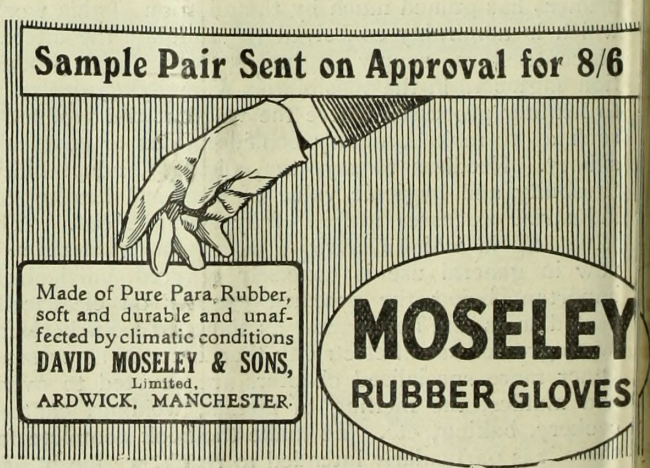
The June issue of the "Sunco" monthly stock price list deals with many standard accessories, as well as with portable electric tools, jointing materials, "Apex" ironclad switch and fuse gear, wireless apparatus, headphones, etc. It should in due course reach all the clients of the **Sun Electrical Co.**, of 120, Charing Cross Road, London, W.C.2. If not received, it will be sent on proper trade application.

Mr. Claude E. Mayer, who has had 18 years' technical experience in shops and drawing-office, and, as such, advertises regularly in our small advertisement pages, has joined forces with Mr. P. J. Linford, a wireless expert, late of the Marconi staff, and they have started business as the **Mayford Wireless Co.**, at 11, The Parade, Upper Brockley Road, London, S.E.4. As retailers they will be pleased to receive trade catalogues and lists from wholesale manufacturers. Postal address: 18, Geoffrey Road, London, S.E.4.

Messrs. Clarkson, Hood and Co., 45, Hope Street, Glasgow, representatives for Ateliers de Constructions Electriques de Charleroi, and of whom Mr. John A. Hood is sole partner, has assumed Mr. A. W. Kilpatrick as a partner in the business. The name of Clarkson, Hood and Co. will be retained, and the firm will continue to act as Scottish representatives for Messrs. Watshams, King Street, Covent Garden, Messrs. E. G. Lind and Co., and for Messrs. Townshends, Ltd., Birmingham.

Barimar, Ltd., of 14-18, Lamb's Conduit Street, Theobald's Road, London, W.C.1, and branches, specialise in heavy welding work, and they will be pleased to advise or assist any manufacturers who have the misfortune to suffer machinery breakages. They state that they have all facilities for giving the quickest delivery of heavy welding repairs done on the site or in their own works. An illustrated and most informative booklet will be sent post paid in response to a post card.

Quite a neat little booklet, entitled "M.E.M. Aims and Claims," has been issued by our good friends, **The Midland Electric Manufacturing Co., Ltd.**, of Barford Street, Birmingham. It sets forth in clear and simple wording the objects which the company has set out to achieve in regard to the manufacture of electrical apparatus of high quality at low prices consistant with the said quality, as well as the manner in which they endeavour to carry them out. It is neatly illustrated with various views of the departments of the works and stores, and altogether does much credit to Mr. Birkett, the sales manager, who was responsible for its preparation. The pamphlet will be forwarded to any trade reader on application.



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A POPULAR SCIENTIFIC WEEKLY JOURNAL
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JUNE 22, 1923.

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THE RESISTANCES OF METALS, ALLOYS AND NON-METALLIC SUBSTANCES.

The resistances of metals and alloys do not bear a simple relation to each other. In this particular alloys behave just as other physical properties do with regard to the metals contained in them, their resistance is not obtained by knowing the proportions of the metals present to form a given alloy. Further, in the case of alloys, the increase in resistance due to rise in temperature is not so marked as in pure metals, for example, *manganin*, which is composed of 80½, 16½ and 3 parts by weight of copper, manganese and nickel respectively, increases in resistance through a small range—0° to 35°C, beyond that the resistance falls slightly as the temperature rises. This is expressed by saying that beyond 35°C. manganin has a small negative temperature coefficient. *German silver*, 4, 1, and 2 parts by weight of copper, zinc and nickel respectively, and *platinoid*, 59, 25.5, 14, and 1.5 parts of copper, zinc, nickel and tungsten, vary little with rise of temperature, the coefficients being .00044 and .00022 in the order mentioned. *Resista*, the constituents of which are iron, nickel and manganese in the proportion of 80, 15 and 5, has a temperature coefficient of .00109. When it is remembered that the value for solid metals is about .0038, it will be seen that alloys are of much service for use in standard resistance coils and high-resistance measuring instruments, as temperature changes do not bring about appreciable discrepancies in their readings.

If R_o, R_t denote the resistances at $o°$ and $t°$, and a the temperature coefficient of increase for a particular metal, then the relation

$$R_t = R_o (1 + a\,t)$$

enables us to calculate the resistance at the new temperature t°C, where a is taken as .0038.

The following shows how pure metals approximate to this mean value, viz. :—

METAL.	TEMP. COEFFICIENT a.
Silver	.004
Copper (hard-drawn)	.00388
Platinum	.0037
Antimony	.0039
Iron (annealed)	.0062
Nickel	.0037
Bismuth	.00345

The resistance thus ranges from the lowest, silver, 1.468 microhms, to Bismuth, 131 microhms per centimetre cube.

The resistance for a metal at constant temperature for any length and sectional area is given by

$R = s\frac{l}{a}$, where R = resistance in ohms.

s = specific resistance in ohms per inch cube.

l = length in inches.

a = sectional area in square inches.

And when the section is circular the formula becomes

$R = s\frac{l}{.7854d^2}$, where d = diameter in inches.

In the case of *non-metals*, the position is not so easily expressed. Generally speaking, when the temperature rises, the resistance falls; for instance, at the temperature of the air the resistance of *carbon* is nearly twice what it is when employed at full voltage in a filament lamp. It has been stated that in experiments conducted with such filaments, when the cold resistance was 600 ohms, the hot resistance at 75 volts was 288 ohms, and remained at this while the voltage rose to 90, from this pressure to that of 140 volts the resistance slowly rose to 293 ohms. For purposes of calculation the temperature coefficient of carbon is taken as minus .00052.

Zirconia, an oxide of zirconium, used in the Nernst lamp, is a non-conductor when cold, that is, it has a high resistance, but when warmed by the platinum heater surrounding it, becomes a conductor; and it is this fact which renders the lamp so effective in operation —the newest form taking only .9 watt per candle at 200 volts. *Gutta-percha* (rubber and sulphur) is another case in point, at 24°C the resistance is 24 times less than it is at 0°C.

For *liquids*, the same law obtains as in non-metals, they have a negative temperature coefficient, the value being .015 per degree Centigrade, although the specific resistance, the "s" in the equation already given, differs widely. A 25 per cent. solution of oil of vitriol has a specific resistance of 1 ohm, and a 5 per cent. solution 4.81 ohms per centimetre cube. Saturated solutions of common salt and salammoniac, bodies much alike in chemical behaviour, have a resistance of 5 ohms, while those of sulphate of zinc and sulphate of copper have resistances of 20 and 30 ohms in the same units.

In the current issue will be found the advert of **Messrs. Chapman and Hall, Ltd.**, who have just recently published various books of interest to quite a number of our readers. They should make a point of writing and asking for prospectus "Y2."

A neatly printed show card quoting testimonials, press opinions, etc., has just been issued by the **Automatic and Electric Furnaces, Ltd.**, of 175, Farringdon Road, London, E.C.1. It should prove of interest to all who have to use hardening steel in which the accuracy of the hardening is absolutely essential.

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THE CROWBOROUGH CENTRAL STATION.

In June, 1899, the Crowborough District Gas and Electricity Co. obtained a special Act authorising them to supply electricity, and in July, 1913, a further Act. Owing to the war, progress could not be made, but in January, 1922, Sir Charles Bright and Partners, Ltd., consulting engineers, were called in to advise the company as to putting the provisions of the Acts into operation, and Mr. A. Hugh Seabrook, who is a director of the firm, has furnished us with the following particulars of the installation.

The area of supply is a very straggling one, and, from the point of view of gas and electricity supply, a "thin" one. It called for high-pressure systems whether for gas or electricity. Such a district required considerable care in the lay-out of the plant and general design to enable a reasonable profit to be earned under the maximum price allowed by the electricity commission.

A point of the greatest importance was that the minimum amount of labour should be required for attending to the system.

Owing to the nature of the district, high pressure had to be employed, 240 volts pressure to the consumers, and 2,400 volts pressure on the transmission lines. In the interests of simplicity and of cheapness, single pole single phase 50 period alternating current was decided upon. The great feature of this system is that there is no balancing and very little regulating required and there is only one live wire to trouble about. Crowborough being mainly a residential district, the power load is likely to be inconsiderable, but in any case, the modern single-phase motor is, for all intents and purposes, as good in every respect as either three-phase or direct current up to 75-80 h.p.

The system is arranged so that the generating and switchboard pressure is 250 volts, and local supplies are given direct. The high pressure is controlled through a low-pressure feeder panel connected with the transformers which are fixed outside the power station, the step-up pressure being 2,500 volts. Thus all high-pressure parts are kept outside the generating station.

No switchgear of any kind is used on the switchboard in connection with the high-pressure feeder cables, the high-tension side of the transformer being connected direct to the feeder cable, while the low-tension side goes to the feeder panel.

This system also enables a very flexible arrangement of pressure to be adopted, as 6,000 or 10,000 volts can be employed in the future if greater distances than the present become involved.

A number of houses and hotels in the Crowborough district are equipped with private generating plants of varying voltages—25, 50, 100, etc. With alternating current the company can give these consumers any

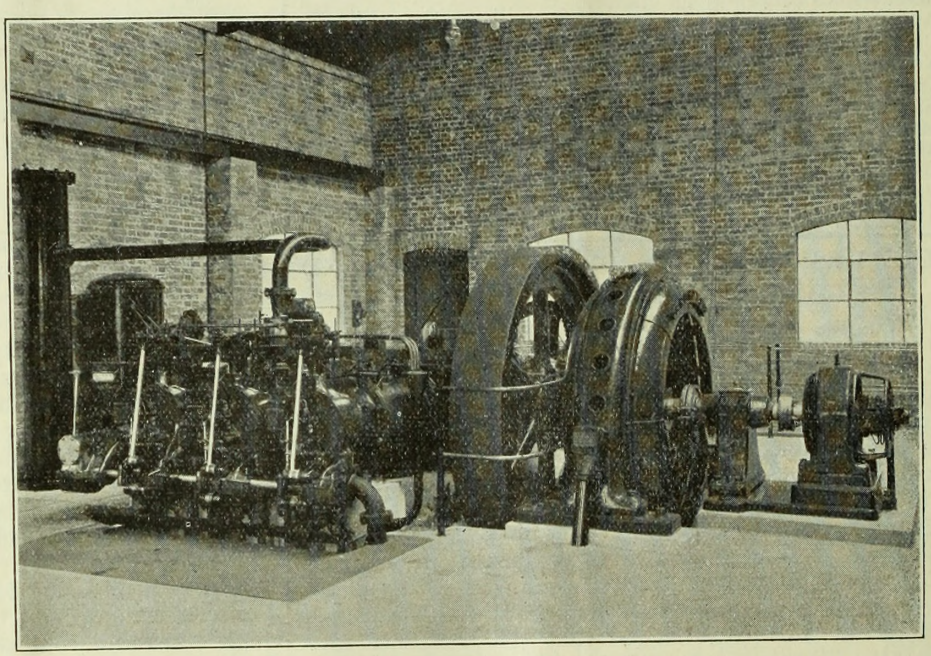


FIG. 1.

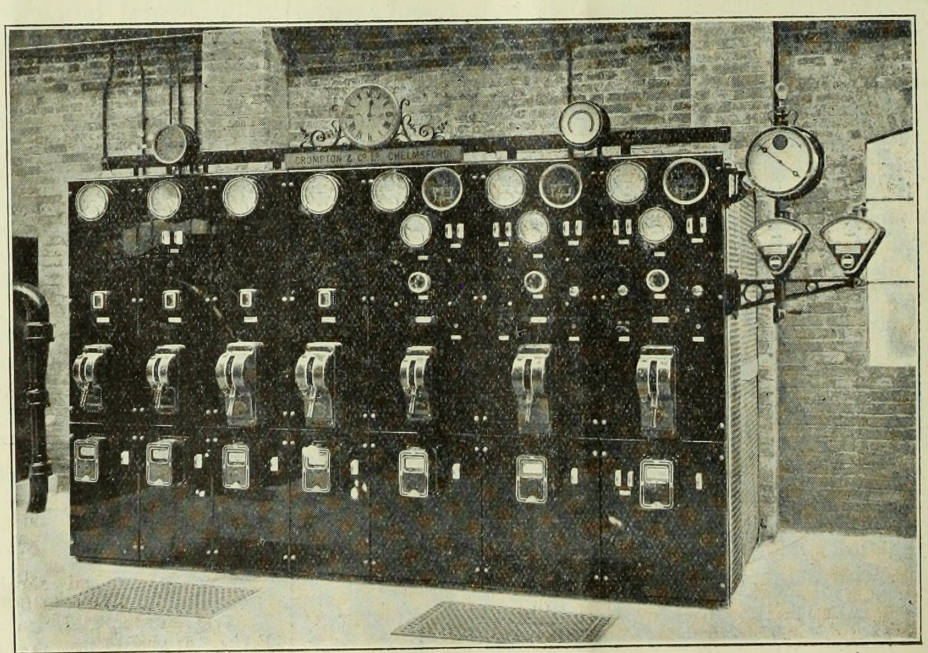


FIG. 2.

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pressure they require—which is a distinct advantage over direct current.

The house to house transformer system has to be largely employed, and low-tension distributing networks are almost non-existent.

The cables were supplied by Messrs. Henley's Telegraph Cable Company, and laid by the company's own staff.

Coming to the generating station, this, as will be seen, consists of a plain serviceable brick, glass and slate building, capable of housing two 100-kw. sets and one 25-kw. set. The 25-kw. set and one 100-kw. set are installed, and during the year probably the second 100-kw. set will go in. It will be noticed that the usual temporary form of end is omitted; the contract price for the building was so reasonable that there was not much difference between a steel and iron end and a brick end.

No money has been wasted on the plant although everything essential has been provided. In the selection of the generating plant special attention was paid to keeping the working expenses at a minimum, consequently a type of engine was selected that requires the least possible attendance, and the small engine runs for hours without any attendance. In fact, there is no permanent attendant in the station at all except when the 100-kw. set is running.

To keep down costs of production town's gas-engines in preference to suction gas-engines are used. Probably suction gas plant would have given a lower fuel cost per k.w.h. It is, however, not only the fuel cost that has to be considered, but fuel with attendance and with repairs, also there is no question whatever that the cost of attendance, repairs and cleaning on engines using town's gas is lower than on an engine using producer gas, apart altogether from the repairs, maintenance and attendance of the gas-producing plant. In this connection it must be borne in mind that the engines are fixed close to the gas holders owned and worked by the same company, and quite a different price per therm can be considered as compared with the price that must be charged on the mains system where distribution costs may probably equal the cost of gas at the works.

It will be observed that an automatic voltage regulator has been installed. This may appear an extravagance for so small a station, but apart from the fact that the absence of a regulator would have necessitated the employment of switchboard attendants, there is the fact that with an automatic regulator a more uniform pressure is obtained than can be effected by hand manipulation of the machines.

The pumping equipment for the cylinder cooling water is combined with the general works pumping requirements, which enables a cheap stand-by supply for the engines to be obtained.

The compressed air starting arrangements also provide a ready means of blowing dust from the electrical plant without the installation of any special apparatus.

The main contractors for the plant and switchboard were Messrs. Crompton and Co., Ltd.; the 100-kw. engine is of the multi-cylinder medium speed horizontal type manufactured by the Premier Gas Engine Company, and the small engine is a twin cylinder horizontal by Messrs. Crossley Bros., Ltd. The automatic voltage regulator is a Taylor-Scotson, supplied and fixed by Messrs. Cox Walker, Ltd., of Darlington. The 5-ton hand operated crane was supplied by Messrs. Woodfield and Company. The building was erected by Mr. W. Godley, of Jarvis Brook, and the whole of the foundations for plant and buildings, trenches, chequer plates and so on, were constructed by the Crowborough District Gas and Electricity Company themselves. Mr. Seabrook states that no clerk of the works was employed, but the whole of the erection and getting to work was carried out under the supervision of Mr. A. G. Cheal, A.M.I.Mech.E., the engineer, manager and secretary of the company.

What is more, Mr. Seabrook states on behalf of his firm that he has never known, in 30 years' experience, a contract to go through with less trouble and with practically no extras, which is an eloquent testimony alike to Mr. Cheal, the contractors and their respective staffs.

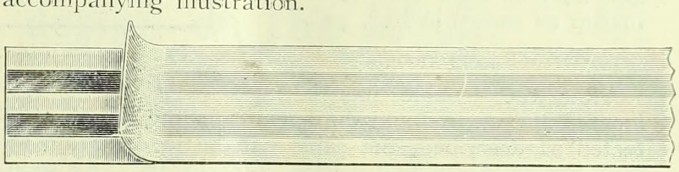
We are indebted to the courtesy of our contemporary, *The Power Engineer*, for the loan of the two illustrations used in this article.

G.E.C. INVISIBLE BELL WIRE.

An Entirely New Departure in Bell Wiring.

Even with the best material and best workmanship the wiring of an electric bell or domestic telephone installation is often far from satisfactory. The wires can never be entirely hidden, and multi-coloured wires secured by the usual staples are not only unsightly, marring the beauty of moulding or panelling, but eventually some of the wires are sure to sag, and thus become a collecting spot for dust and dirt. In attempts to remove this the wires are often broken or pulled down.

A remedy for these troubles is found in the invisible bell wire recently introduced by the General Electric Co., Ltd., of Magnet House, Kingsway, and shown in accompanying illustration.



This bell wire, which is covered by Patent No. 6101/22, consists of twin copper strips 5 by 120 mils laid parallel between two felt paper tapes $\frac{5}{8}$ in. wide and stuck together by special glue. This is supplied in coils of 100 yards and can be fixed on walls under wall paper or distemper, on the ceiling under whitewash, or on the floor under carpet or oil-cloth, when it is quite concealed. If run on the surface it can be coloured or painted to match its surroundings and is then perfectly invisible.

Compared with round wire the G.E.C. invisible bell wire has equal conductivity, and the insulation is excellent. Its invisibility also renders it very suitable for secret wiring for burglar alarms, as the conductors cannot be detected by the most skilful house-breaker.

From the point of view of the installing engineer this new type of conductor has another advantage, for it can be installed with the utmost ease, and thus represents a considerable saving of time and labour in comparison with the ordinary method of bell wiring.

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MAINTENANCE OF TELEPHONE CABLE.*

By Mark T. Caster,

Plant Superintendent, Lincoln Telephone and Telegraph Co., Lincoln, Neb.

(*Concluded from page* 312.)

Protection of Opening.

First compress the wires together lightly and wrap the opening from end to end with two layers of freshly boiled out muslin, extending the wrapping three inches over the sheath at each end of the opening. The two layers of muslin should be wrapped in reverse directions without cutting at the end of the first layer.

The muslin should not be wrapped any tighter than is necessary to produce a smooth surface. Tie the muslin at the end as shown in Fig. 4-*A*. The wrapping should then be boiled out by pouring hot paraffine first on the lead sheath at each end, and then working gradually toward the centre of the wrapping.

The opening should then be wrapped with four layers of two-inch adhesive tape, extending three inches farther back on the sheath than covered by the muslin. The two outside layers of tape should be placed in two pieces beginning at the ends and working towards the centre so as to lap in the manner of shingles. See Fig. 4-*B*.

The cable should then be raised and the centre of the taped portion tied to the messenger with at least four turns of marlin as shown in Fig. 4-*C*.

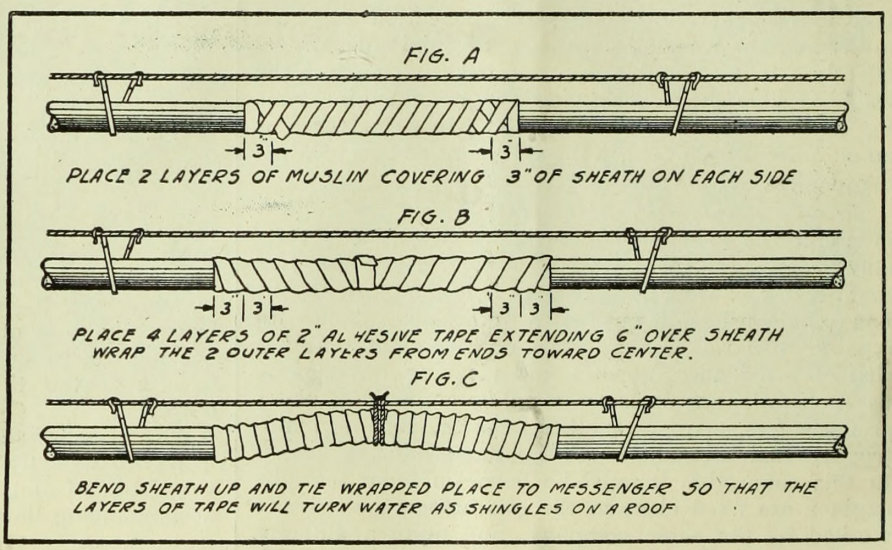


Fig. 4.—Method of Temporarily Protecting the Opening in the Cable Sheath.

Conclusion.

After the trouble has been located and cleared and the opening in the sheath protected as described, the cable will be in condition to give service for a few weeks, if necessary. As soon as possible, however, an experienced cable splicer or a plumber, who can work in the location where the trouble was found, should be secured to replace the lead sheath and complete the repairs in a permanent manner.

When a plumber is employed care should be taken to see that the temporary protection is removed; that the repaired section is again boiled out with paraffine, following closely the instructions referred to in that section. Two or more layers of boiled muslin should then be applied over the conductors in the open section, after which a lead sleeve, just large enough to slide comfortably over the wrapped portion, should be applied and wiped joints made at both ends. Obviously it will be necessary to slit the sleeve in order to apply it.

The plumber or experienced cable splicer will have no real difficulty in doing the lead work satisfactorily.

* *Telephony*, Chicago.

Tenders Wanted.—Particulars may be obtained from the Department of Overseas Trade at 35, Old Queen Street, London, S.W.1, of telephone switchboards which are required by the Postmaster-General's department at Melbourne and also of a complete plant for an isolated station which is required by an important departmental store in Vancouver, British Columbia.

Decimal Coinage, etc.—The June issue of the "Decimal Educator" (published by the Decimal Association, Finsbury Pavement House, E.C.2) contains further details of the Association's proposals with regard to the piecemeal method of obtaining its objects; a taking article by Miss Fortey, M.A., on "Economy"; latest details of progress made since last issue and various items from U.S.A. showing the trend of opinion there.

Personal.—Sir George Beilby, LL.D., F.R.S., has resigned after nearly seven years' voluntary service as Director of Fuel Research and Chairman of the Fuel Research Board under the Department of Scientific and Industrial Research, and the Lord President has appointed Mr. C. H. Lander, D.Sc., M.I.Mech.E., A.M.Inst.C.E., to be Director of Fuel Research, and Sir Richard Threlfall, K.B.E., F.R.S., a present member of the Board, to be Chairman. Sir George Beilby retains his membership of the Advisory Council of the Department, and has consented to act as Honorary Advisor to the Board.

Answers to Correspondents.

BROADCASTING AND THE THEATRES.

To the Editor of Electricity.

Sir,—I notice your remark on the "Avowed hostility of the theatrical magnates whose grievance is largely imaginary." After all, the theatrical interests know their own business best. The public, including the electrical world, hardly has any right either to suggest or to advise the entertainment industry to take any line with its property, which it has built up with so much care and patience, unless it approves that line itself. This is a purely domestic matter, and before it will consider the issues at all, the entertainment industry intends to have its position regularised from the official standpoint. It naturally considers that it is quite time to stop all attempts at what I may call easy exploitation.—Yours very faithfully,

Charles Watney,
Parliamentary Representative.

13, Courtfield Road,
South Kensington, S.W.7.
June 12, 1923.

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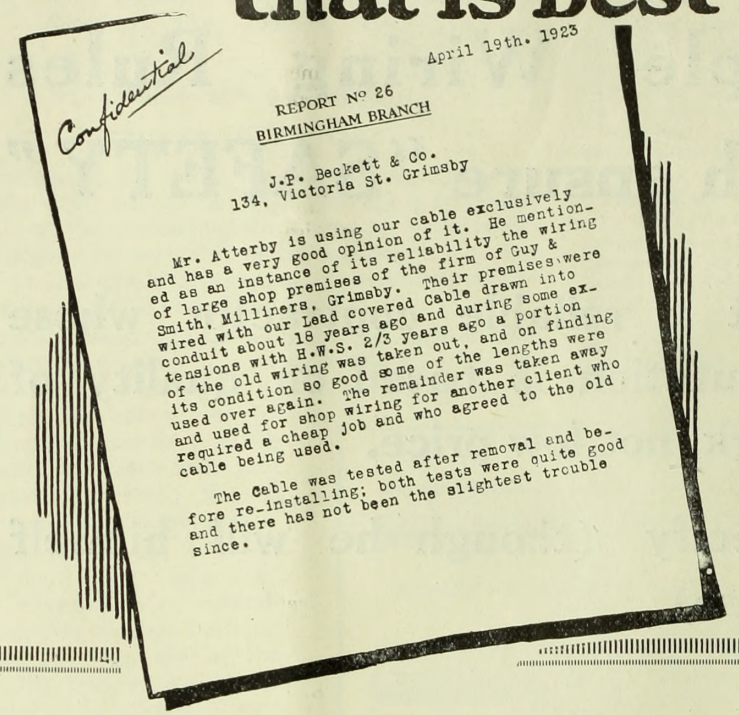
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A Confidential Report that is best made public-


Confidential

April 19th. 1923

REPORT No 26
BIRMINGHAM BRANCH

J.P. Beckett & Co.
134, Victoria St. Grimsby

Mr. Atterby is using our cable exclusively and has a very good opinion of it. He mentioned as an instance of its reliability the wiring of large shop premises of the firm of Guy & Smith, Milliners, Grimsby. Their premises were wired with our Lead covered Cable drawn into conduit about 18 years ago and during some extensions with H.W.S. 2/3 years ago a portion of the old wiring was taken out, and on finding its condition so good some of the lengths were used over again. The remainder was taken away and used for shop wiring for another client who required a cheap job and who agreed to the old cable being used.

The Cable was tested after removal and before re-installing; both tests were quite good and there has not been the slightest trouble since.

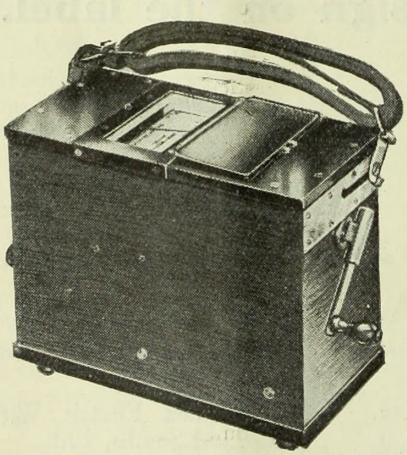
Another Henley Cable that is working over time

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W. T. HENLEY'S TELEGRAPH WORKS Co., Ltd.,
Blomfield Street, London, E.C.2.

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OHMMETER



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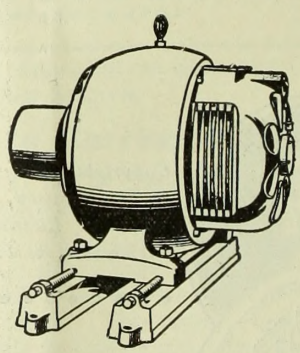
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TO OUR READERS.

ELECTRICITY is published every Friday, and, if ordered, is on sale at the principal Railway Station Bookstalls and Newsagents on that day. It has a very large sale throughout the United Kingdom, as well as in the British Colonies and Abroad.

New advertisements for the displayed columns and alterations to existing ones must reach the publishing office not later than first post Tuesday morning, in order to be in time for the issue of the following Friday. This is important. Rate quoted on application. Subscription: 13s. a year, 6s. 6d. half year, 3s. 3d. a quarter in advance, postage prepaid in the United Kingdom and abroad.

Questions to which an answer is required must be accompanied by a 1½d. stamp for reply. When considered of sufficient interest, the answer will probably appear in the paper.

All remittances payable to the Publishers, S. RENTELL AND CO., LTD., 36-39, Maiden Lane, London, W.C.2. Telephone No. 2460 Gerrard.

Current Topics.

Conventional or Original?

In the development of any new invention or application of science to everyday requirements, it is remarkable how slavishly we follow conventional design, and how difficult it is to persuade designers, manufacturers, or the purchasing public to consider any radical departure. For example, when the motor-car made its first appearance it was, in effect, a horseless carriage, the shafts having been removed and an engine placed as nearly as possible in the position previously occupied by the horse, viz., in front of the vehicle, and there it remains to this day, more than a quarter of a century afterwards. Much the same applies to electric heating, for the conventional electric fires of to-day are made to resemble the open glowing coal fire as closely as possible, and, what is more, are placed, in nine cases out of ten, in the fireplace, and the original flue left unsealed, with the result that at least 50 per cent. of the resultant heat goes up the chimney.

The evolution of electric heating affords rather an interesting study, for, commencing with the lamp radiator or group of heavy current tubular carbon filament lamps mounted in front of a reflector, it passed through an era of convectors, in which the source of heat was invisible, and it was sought to raise the temperature of the surrounding air rather than communicate warmth by direct radiation. Then came the infinitely wider field of application opened up by the introduction of ni-chrome wire and ribbon, with its well-known resistance to fusion or oxidisation at high temperatures, and immediately there was a return to the conventional glowing fire effect, supplemented latterly by reflections which tend to increase the radiation, but do not, of course, augment the total heat generated.

Latterly, there is a tendency to revert to invisible heat sources, *vide* a system recently described in which electric heat is generated at comparatively low temperature from elements made up in screen or matting form, thus emulating the American hot-air system of heating, or the practice in some British hotels and hydros of central heating and distribution by either steam or hot-water radiators. It would appear that the science of electric heating in its application to houses and enclosed spaces generally is even yet improperly understood, and that its sponsors have contented themselves with gauging the public fancy rather than studying the fundamental and withal very simple principles, and applying them in the simplest and most efficient manner to the requirements of the times in which we live. When all is said and done, electrically generated heat is the most easily controlled, readily applied, and efficient method of adding to our bodily comfort that we possess in the light of present knowledge, and there is every reason to turn it to best advantage by applying it in the scientifically correct manner, whether that method of application appeals to the public for the time being or otherwise.

Electric heating will never be permanently popularised by presenting it in a dainty or attractive form. The man who buys an electric fire because it is of generally pleasing design, and looked glowing and comfortable when he saw it in the dealer's showroom, is not going to retain it permanently in service if he receives, say, a £20 bill for current consumed at the end of the first six months after it is installed. You may sell that man one electric fire but you will never sell him another, and, what is more, he will take care to warn all his friends against the inordinate cost of electric heating. Catering for public taste in such things as electric fires is essentially not the way to build up a trade in such goods, or to create a heating load on the power station.

To my mind, the true solution of the application of electric heating is not yet discovered; we have been so busy playing to the gallery and extolling the respective merits of radiation and convection methods of transforming heat energy to rooms and their occupants that we are missing the real point, viz., the most economical means of applying electric heat to any given set of requirements. Already we have a very energetic and efficient Illuminating Engineering Society which has enormously advanced the cause of electric lighting by its thorough treatment of the manifold problems of lighting, and its recommendations in connection with special cases which would otherwise have remained as discreditable examples of the inefficient application of electricity to illumination. Now it would appear that we are also equally in need of a similar body to study and give practical shape to the unplumbed possibilities of electric heating. It is an applied science which hitherto has been left too much to the purely manufacturing side of the industry, in which dividends wait upon satisfying a too-frequently misguided public taste.

The Institution Tour.

The various visits paid by the touring members of the I.E.E. seem to have been full of interest, and should tend to add to their general knowledge and experience, as well as strengthen the social and commercial bonds between those visitors who seldom journey far from their own headquarters at other times, and therefore have no opportunity of meeting industrial contemporaries with whom they may nevertheless have much in common. These visits lead to many happy reunions of old friends and contemporaries who have not met for years, and bring about a change of ideas and experiences which is all to the common good of the profession, as well as of the industry which it controls. I was present at one of the visiting functions, and should like to offer a little well-intentioned criticism for the benefit of next year's tour.

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In the particular case referred to a party of about forty was expected at a certain works, and special provision was made for their reception and personal conduct through fairly extensive departments. The party was to be divided into small groups for the better and more personal contact with their respective guides, who were selected for their intimate knowledge of the details of the organisation which was to be honoured with a visit. Everything was in readiness, and the party duly arrived half an hour late, some twenty-four strong, without a definite leader or courier, and in a state of glorious uncertainty as to whether it represented the sum total of all who might be expected, or whether there were others to follow. In view of this uncertainty, another half hour was partly wasted in waiting for stragglers, of whom some half-dozen arrived at intervals.

In spite of the disabilities arising out of this missing link in the effective organisation of the visiting party, the firm were able to make their visit a thoroughly interesting and enjoyable function, but it might very readily have become a fiasco, as the time available was very limited, some two and three-quarter hours all



MR. HIRST TELLS THE PRINCE THAT TRADE IS IMPROVING.

told. The point I wish to make is that, when various firms in the industry go to the trouble of organising an official visit of this character and go out of their way to make such a visit interesting and enjoyable to all concerned, it is up to the responsible officials of the Institution to see that, however its party is split up, the movements of individual groups or bodies of visitors should always be under the control and guidance of a responsible official or courier, who could act as spokesman, introduce the visitors to the firm's officers, and generally give such information as is necessary to ensure smooth conduct of the function from start to finish. In the case I witnessed there was a definite absence of any such leadership.

Congratulations to Mr. Hirst and the other directors of the G.E.C. on the brave show made by their ex-Service employees when H.R.H. the Prince of Wales visited the works at Witton early last week. It was a very happy gathering that assembled to welcome the nation's finest commercial traveller, and it is pleasant to be able to record Mr. Hirst's remarks to the Prince to the effect that business had improved steadily during the last nine months and had now almost returned to normal. In fact, one can almost read the satisfaction on Mr. Hirst's face in the annexed photograph. Not only was the Prince delighted with the news, but he also expressed his keen pleasure with the smart and exceptionally fit appearance of the thousand odd ex-Service men whom he had just inspected on the sports ground. This was an excellent testimonial to the G.E.C. welfare organisation, in which the directors take great pride.

Witton's Welcome—

Some of the employees to whom the Prince was introduced were regular veterans in the company's employ. For instance, Mr. W. E. Simmons had been with them 39 years, Mr. J. Gibson 28 years, Mr. W. Hulme 29 years, and so on, including Mrs. Matty, of the carbon works, who had been with them 20 years. Unfortunately time did not permit H.R.H. to make a minute inspection of the works themselves, but he gave Mr. Hirst a definite promise that he would take an early opportunity of doing so, and he remarked on the good feeling which evidently existed between all members of the staff. Altogether the function was a very pleasant one, of which the G.E.C. directors and staff may well feel proud.

—to the Prince of Wales.

ELEKTRON.

VOLTAGE REGULATION FOR CONSTANT POTENTIAL SUPPLY.

A constant potential supply is one where electric energy is maintained such that the voltage is kept constant by various devices, although the load may vary.

For a D.C. power supply, especially where the motors may have speed variation, the voltage regulation is elastic—a range of 5 per cent. up and 5 per cent. down may be allowed, the machinery speeding up or falling off within the limits of this range, and the same applies to a supply for electric traction.

For a lighting circuit, however, different conditions obtain, and it is generally allowed that the range should not exceed 2 per cent. up and 2 per cent. down. The reason for this is not far to seek. Whether we are using carbon or metal filament lamps, a steady light is only obtained when the voltage is steady and, moreover, the life of such a lamp is reduced considerably when subjected to varying voltage. Experiment has

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shown that the candle-power is increased 11 per cent. when the voltage rises 2 per cent., and, further, the "life" becomes only 70 per cent. of its normal number of hours. With a 2 per cent. lowering of voltage, there is a 10 per cent. decrease of candle-power.

There are several contributing causes of variation in voltage.

(*a*) *In the prime movers* there may be variation in steam pressure, or if a gas engine is employed differences in the composition of the gases and in the frequency of ignition. With a hydraulic plant, the "head" of water may change. Such causes, of course, are non-electrical, and belong to the province of the mechanical engineer.

(*b*) *Temperature changes.*—When running on load for some time, the various electrical losses appear as heat, and if this is not dissipated as fast as it is formed, the generator windings and armature warm up. This causes an increase in resistance and, therefore, a larger voltage drop, and consequently the field is weakened because of the lower current circulating in the field coils.

(*c*) *Loss of voltage in feeders.*—Whenever a current passes from the generator to a distribution point, there will be a voltage drop, the product of the current and the resistance of the feeder cable, this will be symbolically represented by *CR*, *R* increasing as the length of the cable. The actual voltage at the point of supply will, therefore, be diminished by this amount.

(*d*) *Variable loads.*—At the generating end, if we have correct voltage for a given load, directly the load changes, so will the current, and this will produce a voltage drop different from the former. In the case of suddenly starting and stopping heavily loaded motors, this *CR* drop will vary considerably.

Regulation.—(1) For generator voltage.—Apart from speed changes, where electrically-operated governors act on the prime movers, the chief regulation is effected by varying the field strength to compensate for the loss of voltage due to rise of temperature in the armature. Where alterations in the load take place, the generators may be compounded or over-compounded. (2) For station voltage.—The load should be, as nearly as possible, equally distributed, and the voltage kept just as high above the receiving end as is suffered by the drop in the line. Clearly, the voltage at a receiving point *near* the generator will be higher than that at a *distant* point. To take a case in point, if we have a lighting circuit with a line drop of 5 volts, with lamps distributed along the circuit, then we should burn lamps rated 5 volts higher at the near end than those at the distant end. (3) For feeder voltage.—To regulate this, a storage battery may be connected across the feeder circuit. When the voltage rises above specification, current flows from generator to battery. When the voltage falls below specification, current flows from battery to circuit and assists the generator, thus maintaining constant voltage. The e.m.f. of the battery may be varied by cutting out or in end cells by a switch, this applies for gradual fluctuation of load; for sudden fluctuations a reversible series booster is used in conjunction with the battery. On heavy load, the booster generates an e.m.f. in the direction of battery discharge, and on light load, the booster charges the cells by setting up an opposing e.m.f.

Questions and Answers by Practical Men.

RULES.

QUESTIONS: *We invite our readers to send us questions, preferably on technical problems that have arisen in actual practice. Questions which we consider of sufficient interest to our readers will either be replied to under "Answers to Correspondents" or replies will be invited from our readers. One shilling will be paid for the question which we select for competitive replies in this column.*

ANSWERS: *A fee of 10s. will be paid for the answer which we consider shows the greatest merit, and 5s. for the one we select as second best. In judging the replies, importance will be attached to clearness and conciseness, as well as accuracy. The Editor reserves the right to make no award, or to accept only one reply, if, in his opinion, the answers received do not possess sufficient merit. Competitors desiring the return of their manuscripts, if unaccepted, should enclose stamped addressed envelope.*

Write on one side of the paper only, and if diagrams are sent, draw them on a separate sheet of paper attached to the manuscript. Competitors may adopt a "nom de plume," but, both in the case of questions and answers, the competitor's real name and address must be sent with the manuscript as a guarantee of good faith. No correspondence will be entered into with regard to successful replies. The Editor's decision is final.

Commencing with Question No. 101, a Diploma of Merit will be awarded to the six competitors who win the first or second prize the most times during the next twelve months.

The words "Questions and Answers" or "Q" and "A" should be placed at the top left-hand corner of all letters intended for this column.

QUESTION NO. 161.

Are there any hard and fast rules for the earthing of motors? The other day one of my motors, 10 b.h.p., 440 volts D.C. 3-wire, developed an earth. To my surprise, the earth wire, connected from the motor to the conduit, fused. This wire was about $\frac{1}{8}$ in. copper. As this was evidently not strong enough, what wire should be used?—"EXAMINER."

QUESTION NO. 162.

Can any reader give me details of the facts which govern the choice of high-tension insulators? I have heard talk of "Corona effect." What is this? Does it affect insulators used on voltages of over or under 6,600 volts?—"JOINTER."

(*Replies to Questions Nos. 161 and 162 must be received not later than June 30, 1923.*

Answers to Questions.

ANSWERS TO QUESTION NO. 157.

The second prize (5s.) has been awarded to Staff-Sergeant H. J. Raymond, 1st A.A. Battalion, R.E., Blackdown, near Aldershot, for the following reply:—

The usual form of Nodon valve consist of four cylindrical containers, in each of which is a cylinder of lead or iron surrounding a central rod of aluminium,

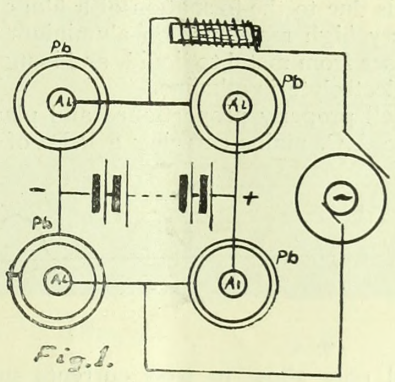


Fig. 1.

which is sheathed the greater part of its length by a glass tube.

The liquid electrolyte with which cells are filled is concentrated solution of ammonium phosphate.

The scheme of connections is shown in Fig. 1, where Pb and AL represent the lead and aluminium electrodes respectively.

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The A.C. supply is led in as shown to the two dissimilar junctions and the D.C. taken off between the similar junctions of lead and aluminium, the positive pole being at the aluminium junction and the negative at the lead junction.

This form of valve will work with A.C. voltages ranging from 50 to 140 volts, and is practically independent of the frequency between 25 and 200 periods.

Its efficiency ranges from 65 per cent. at 42 periods to 75 per cent. at 84 periods, and the E.M.F. is reduced about 10 per cent. in process of transformation.

The temperature at which the valve is worked has an important bearing on its behaviour, and for highest efficiency should not exceed 30 degrees C., that is 86 degrees F., although the valve is still workable up to 50 degrees C., *i.e.*, 122 degrees F.

For small capacity valves up to, say, 4-kw., regulation may be effected by a choking coil in series with main A.C. leads. Adjustment may also be effected by insulating sleeves which pass over exposed surface of aluminium rod, and serves to vary the area of metal exposed to electrolyte; as this latter form of adjustment does not affect efficiency it is preferable to use this method on valves of higher capacity.

To make one suitable to carry, say, a current of 5 amperes, four cells about the size of an agglomerate block Leclanché cell will give good results; in fact, four such earthenware containers as used in above cells could be used, the cylinder of lead of about No. 16 gauge being about the same size as the cylindrical zinc plate used in this form of Leclanché cell. The aluminium rod should be approximately one-third of diameter of lead cylinder.

The four cells could then be mounted upon an ebonite base, pillars of brass rod being fixed at each corner upon which, at their upper ends, a similar piece of ebonite is mounted, the pillars being threaded at their upper ends in order to enable the top piece of ebonite to be clamped down over the four cells. The necessary terminals for connection can be mounted upon this upper ebonite slab, thus ensuring a compact arrangement. With the above described piece of apparatus, current can pass freely when the aluminium is the cathode or negative plate, but experiences a great resistance when it becomes the anode or positive plate. This effect is due to the formation of a film of insoluble oxide of very high resistance on aluminium rod where current passes from metal to liquid, and is most marked when the electrolyte is alkaline.

Such a cell properly proportioned and placed across single-phase A.C. mains carrying a P.D. of sine wave

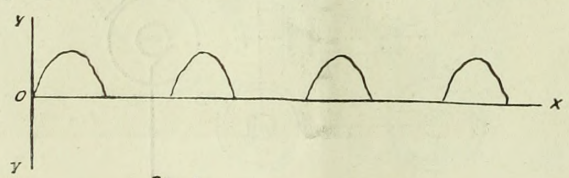


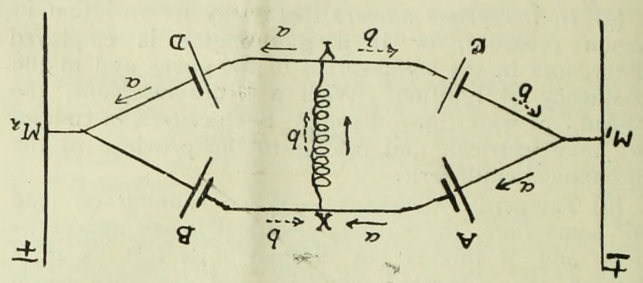
Fig. 2

form would only allow to pass currents such as are shown in Fig. 2, *i.e.*, all the negative loops would be suppressed, and only those loops would persist in which aluminium rod acted as cathode.

Such is the broad outline of the principal underlying action of Nodon valve.

Such a cell alone would not be of much practical utility on account of the comparative long no-current intervals, but by the combination of four such cells unidirectional currents can be obtained as desired, which will be seen by Fig. 3. In this diagram, when M1 is positive, the direction of current is shown by

Fig. 3



full line arrows, and when M2 is positive the direction of current is shown by dotted arrows, and it can easily be seen that the current always flows from X to Y if these points are connected through a suitable current consuming device.—H. J. RAYMOND.

ELECTRICAL PROGRESS IN LONDON IN TWENTY YEARS.

In the report of the Public Control Committee, which was submitted at the meeting of the London County Council on Tuesday last, there was an interesting table showing the increase in the use of electricity in the metropolis during the last twenty years, and we do not think we can do better than reproduce it.

Number of units sold for lighting, power and heat:—

Year.	Undertakings of Metropolitan Borough Councils. Units.	Undertakings of London Companies. Units.	Total. Units.
1900-01 ..	11,803,307	54,461,853	66,265,160
1910-11 (or 1910)	86,529,629	137,617,155	224,146,784
1920-21 (or 1920)	179,305,740	270,240,861	449,546,601

It is interesting to note that the increase in the consumption of electricity is almost entirely due to its extended use for power and heat. Under this heading there was an increased consumption of 186 million units in the interval of ten years between 1909 and 1919. In 1909 the number of units sold for power and heat was approximately 70 millions; in 1919 it had increased to 256 millions. As in the case of the gas mantle, improvements in the electric lamp have very considerably increased the efficiency of current for lighting purposes, and consequently, although the use of electricity for lighting purposes has increased, the amount of current required is not appreciably greater.

The use of electricity for traction purposes has also largely increased in recent years, and its further development in this direction will be an additional factor in the improvement of the atmosphere of London.

The actual subject of the report in which the above information appeared was "Atmospheric Pollution and Fog Prevention," and farther on it states, as the considered opinion of the Committee, that they are "of opinion that the time has arrived when the use of the

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old-fashioned kitchener might well cease. As compared with modern electric and gas cooking appliances, it is inefficient and out of date, and probably wasteful of fuel. It must be held responsible for a very large proportion of the smoke arising from domestic chimneys."

We can quite imagine E. D. A. Beauchamp and all makers of electric cooking and heating apparatus chortling merrily and girding their loins in readiness for the campaign to book orders for apparatus to be installed in the coming autumn. At any rate, the above quotation is a big point in our favour, and should most certainly help our industry to a very material extent.

MANUFACTURE OF LAMPS.*

(*Continued from page* 319.)

Anyone who has used an air pump knows that if a few drops of water are placed in a vessel which is then exhausted, the water evaporates almost immediately, whereas drops of water placed in dry air evaporate quite slowly.

Perhaps this will be better appreciated after reference to Fig. 2, which represents molecules of tungsten evaporating from the surface of a filament. In the absence of gas molecules, the tungsten molecules would go off in straight lines until they reached the surface of the bulb, but the gas molecules get in the way and many of the tungsten molecules bounce back on to the surface of the filament. The gas does not reduce the number of molecules which leave the surface, but in does greatly reduce the speed with which they get away permanently. Hence the introduction of gas into a lamp will reduce the speed of evaporation and enable us to operate the filament at higher temperatures.

Referring again to Fig. 1, we see that, considering radiation alone, increased temperature means a smaller proportion of useless energy, *i.e.*, less energy which cannot stimulate vision.

But when we introduce gas into a lamp, we bring in another factor besides radiation which influences the proportion of useful to useless energy, viz., convection and conduction of heat energy through the gas.

Therefore, when a filament is operated in gas at a higher temperature than is possible in vacuum, it does not necessarily follow that light is produced more efficiently; in fact, all early experiments with carbon lamps showed that the increased loss of energy due to conduction and convection through the gas was greater than the reduction in the proportion of useless energy associated with the increased operating temperature.

But important laws governing the loss of energy by conduction and convection from hot bodies were not then known. As a result of research, Dr. Langmuir showed that when a wire is heated in a gas there is a layer of stationary gas on the surface of the wire, held by a sort of friction, and that the thickness of this layer was practically constant for all sizes of wire. The energy lost through the gas is principally that carried away by convection, *i.e.*, by the streaming gas outside the stagnant layer, and this lost energy is proportional to the area of the outside of the stagnant layer. Now, both the useful energy and useless energy radiated by the hot wire are proportional to the area of the wire. Therefore, the ratio of useful to useless energy for a hot wire in gas does not depend solely on the area of the wire surface, but is influenced by the ratio of the surface of the stagnant layer of gas to the area of the wire.

Referring to Fig. 3, it is obvious that the proportion of useless energy will be much more pronounced for the small wires than for large ones, so that it is only in the larger wires that a gain in efficiency can be expected when gas is used in a lamp.

You would naturally ask at what diameter of wire is there a definite gain in efficiency when the wire is operated in a gas at the maximum temperature for reasonable life. The diameter is such that if a lamp for 100 volt circuits is required it would consume over 1,000 watts, so that at first sight it does not appear possible to make use of gas filling for the more usual household lamps.

But this difficulty was overcome by Langmuir, who

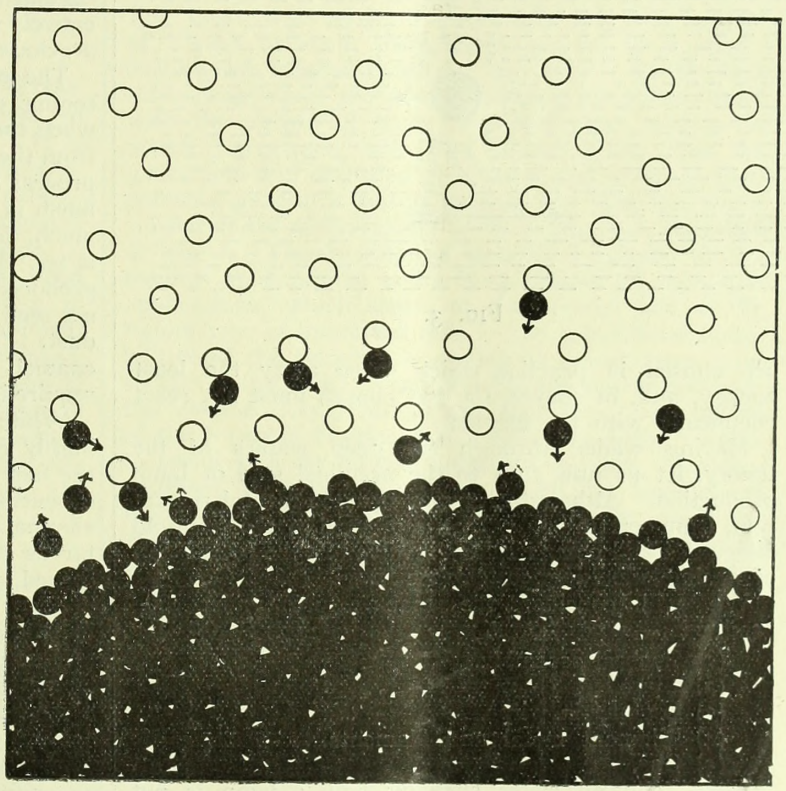


FIG. 2.

used a simple yet ingenious device, viz., by winding the filament in the form of a close spiral. It is scarcely necessary to say that this calls not only for good mechanical properties in the wire, but also for ingenious machines and methods of spiralling, as the wires to be spiralled for household lamps are only 0.02 mm. to 0.05 mm. in diameter.

That this device succeeds I can illustrate by means

* Paper read by Bernard P. Dudding, Esq., before the National Association of Supervising Electricians.

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of a gasfilled lamp in which a portion of the spiral has been drawn out nearly straight. The straightened filament will only just begin to glow when the spiralled portion is approaching 3,000 degrees Centigrade, although the same current is traversing the two portions of the wire.

In conclusion, experiments also showed that all gases did not carry away heat at the same rate, so gases

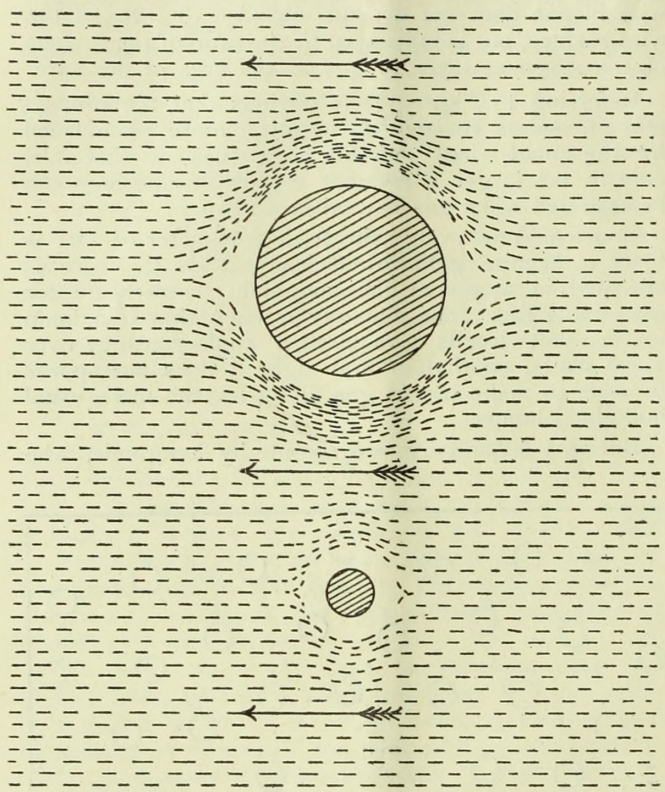


FIG. 3.

are chosen in practice which carry away the least energy, and, of course, the gas chosen must not react chemically with the filament.

Having waded through the deep waters of the theory, let us now turn to the practical side of lamp production. Although this may provide mental relaxation, I am certain you will be impressed by the manifold difficulties and complications involved in the production of a simple-looking 3s. electric lamp.

We will consider the manufacture under five headings :—

(1) General assembly.
(2) Glass.
(3) Leading-in wires.
(4) Filament metal and filaments.
(5) Gas.

Then followed slides showing how a lamp is put together

GLASS.

I have on the table samples of the ingredients which are used to produce the ordinary clear glass tubing and bulbs used in lamps, and, in addition, I have samples showing various stages in the founding of this glass.

For lamp making the glass must be capable of reheating many times without excessive cracking and without any of its constituents tending to crystallise out.

Two other properties of glass are of intense interest to the lamp maker. Glass, commonly looked upon as a good insulator, is really a conductor, especially at high temperatures. It carries current in the same way as a solution of common salt does, that is, by electrolysis, and suffers decomposition in the process. These electrolytic products would be detrimental to the lamp, and so the composition of the glass has to be chosen so that no appreciable amount of electrolysis of the glass takes place under lamp operating conditions.

The other property of glass to which I should like to make reference is the tenacity with which a film of gas adheres to its surface, which must be removed if a satisfactory vacuum or gasfilled lamp is to be made.

This property of glass we shall refer to again, and I hope to show you at the end of the lecture the effects produced by not removing this layer of gas.

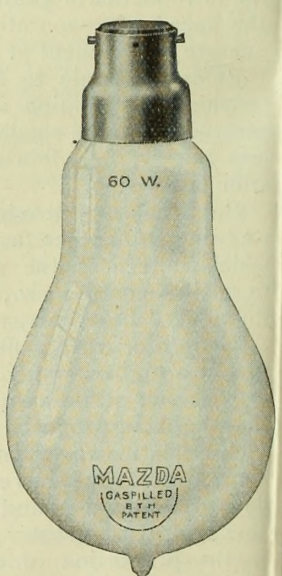
(To be continued.)

THE LATEST DEVELOPMENT IN GASFILLED LAMPS.

THE WHITE MAZDA LAMP.

"White Mazda Lamp" is the name given to the regular Mazda gasfilled lamp when obscured by an entirely new process, which has many advantages over previous methods.

The process is particularly effective as a means of toning down the glare produced by gasfilled lamps, when they are used without shades, to screen the eyes from the direct rays. By means of a special enamelling process applied to the exterior of the bulb a permanent finish is obtained equal to that of opal glass, and at a much lower cost than the latter. Moreover, the surface produced is smooth and does not tend to collect particles of dust. The density of the enamel can be varied as required.



THE WHITE MAZDA LAMP.

White Mazda lamps are highly efficient by reason of the fact that only just enough obscuring medium is used to eliminate the glare, while, so far as light diffusion is concerned, they have been proved in every way the equal of opal bulb lamps.

Wherever ordinary gasfilled lamps are used for direct lighting, either with or without shades (or where they would be used but for their uncomfortable brillance and glare), white Mazda lamps should be installed. For residence lighting they are, of course, eminently suitable.

These new lamps can be supplied in all sizes up to 300 watts at prices 10 per cent. above those charged for ordinary gasfilled lamps.

The British Thomson-Houston Co., Ltd., have prepared an attractive folder giving particulars and prices of white Mazda lamps, and overprinted copies can be obtained on request.

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Reviews of Books, &c.

[*Books noticed in this column will be sent from* ELECTRICITY *Office to any part of the world, for the published price, plus ten per cent. for postage (minimum 2d.), and orders will be appreciated.*]

WIRELESS COMPONENT PARTS AND HOW TO MAKE THEM. (Cassell, 1s. 6d. net.)—This is the first volume of the amateur wireless series of handbooks, a series which in style and editorship will be closely allied to the famous "Work" handbooks issued by the same publishers. This brief remark alone should convey to intending purchasers, who are acquainted with "Work" handbooks, some idea as to the type and scope of the book. To the wireless amateur possessing the smallest of workshop facilities, the information given is of very great value. The design and manufacture of all kinds of amateur wireless component parts is very thoroughly gone into, unnecessary details being omitted, and the general construction being left to the experimenter. We do not, however, like the first chapter, which gives a brief description of various parts and their uses, because, as a rule, the amateur sufficiently interested to purchase the book already has such knowledge. The book as a whole is well written, amply illustrated, and full of valuable hints and tips to wireless amateurs.

THE BOOK OF THE FORD. (Temple Press, 2s. 6d. net.)—A new and seventh edition of this well-known work has just been issued. It is the most practical handbook of instruction on the construction, driving, and upkeep of the Ford car extant, and is written in the simplest non-technical language by Mr. R. T. Nicholson, who has for years made an exhaustive study of the Ford, specially for the Ford owner-driver. Stated briefly, there is everything in this handbook that one ought to know about the Ford. There is a wealth of practical information profusely illustrated on adjustment, minor repairs and economical upkeep. The latest model with the right-hand drive is dealt with in a new chapter, and the new carburetter, hood and other details are treated and new illustrations included. The text has been fully revised and the index extended.

BOILER PLANT TESTING. By David Brownlie. 168 pp., 21 figs. (Chapman and Hall, 10s. 6d. net.)—Although this book is primarily a plea for the establishment of a standard international boiler testing code it is, in fact, the best book on boiler testing which it has yet been our good fortune to see. The author has undertaken tests on many hundreds of boilers in all classes of installations, so that he is able to speak from the widest practical experience. In discussing the many defects of the existing standard boiler testing code of the Institution of Civil Engineers, Mr. Brownlie shows clearly what are the actual practical conditions and requirements, and it is safe to say that the student can learn from this volume all that is to be learnt from books in the matter of boiler testing. In the first part of the book the author deals carefully with the results at present being obtained on boiler plants in general. This shows unmistakably the necessity for adopting modern scientific methods in steam generation and for devising a practical testing code to encourage this work. The necessity for this becomes more obvious when it is remembered that nearly 50 per cent. of the coal consumption of Great Britain is used for steam raising in boilers. The second part of the book constitutes criticisms of existing codes and suggestions for improvement. Although the book has only been published for a short time it has already commanded the respect and approval of all classes of engineers in regard to the criticisms and proposals which it contains. The remaining two parts of the book contain suggestions for new features which might be added to the international code as a result of further discussion and investigation, and an admirable design for report sheets under the new code.

We have not the slightest hesitation in recommending this book to the careful study of students and engineers in practice. To both of these classes, and to any steam user, the book is indeed invaluable.

PRACTICAL APPLICATIONS OF X-RAYS. By G. W. C. Kaye. 135 pp., 96 figs. (Chapman and Hall, 10s. 6d. net.)—As indicated by its title, this book deals principally with the practical applications of X-rays, but it contains a sufficient treatment of the fundamentals of the subject to meet the requirements of most readers. For those who wish to go deeply into the subject of X-rays as such, there is, of course, the author's well-known treatise entitled "X-Rays." In the first three chapters of the present volume the author deals with the nature of these rays and their relation to atomic structure; with the X-ray bulb, and the generation and detection of X-rays; and with the high potential generator and its accessories. The important subject of the measurement of X-rays is then discussed at length. This is followed by a short chapter on the medical applications, and a long chapter on industrial applications, which latter, to the layman and to the reader who is interested only in the commercial possibilities of the subject, is perhaps the most interesting section of the book. Very valuable appendices conclude the volume. As Head of the Radiology Department of the National Physical Laboratory, the author is able to speak with the highest authority and has, no doubt, facilities for conducting work which are beyond the reach of most investigators. The reader gains the advantage of this. Twenty-five years ago it took 20 minutes to obtain a very poor radiograph of the human hand; to-day, a picture which is photographically perfect can be obtained in one-hundredth of a second. Modern X-ray equipment will penetrate 2 ft. of wood, 6 in. of aluminium, 3 in. of steel, and $\frac{1}{4}$ in. of lead. It will detect flaws in welds and in the spliced bars of aeroplanes, etc.; it will reveal the filling of a cartridge or rocket; it will show the coils and wiring of an electrical instrument, and reveal the broken wire in an airman's electrically-heated coat; it will show what is inside the pneumatic tyre cover and where lead paint has been used to fill the joint of a limber wheel; it will show what is the matter with the interior of a golf ball, and it will reveal a picture painted over by another hand centuries ago. These are only a few of the many applications of X-rays described and illustrated in this book. If you are in the slightest degree interested in this fascinating subject, buy this volume—profit and pleasure will be the result.

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Various Items.

Uruguay.—Outdoor cable is required for the State Electric Light Works at Montevideo. Specifications and samples can be seen at Room 52, D.O.T., 35, Old Queen Street, London, S.W. 1.

West of Scotland.—The Electricity Commissioners have extended until December 31, 1923, the time within which objections may be raised to the scheme for the West of Scotland electricity district.

Vacuum Cleaners for Telephone Equipment.—In our issue of June 8, on page 304, we inserted an article dealing with vacuum cleaners for telephone equipment, and we are now informed by the Hot-Point Electric Appliance Co., Ltd., of 21, Berners Street, London, W. 1, that the special type of cleaner to which we referred can be obtained from them.

Wages Agreement.—At the official conference between the executives of the N.F.E.A. and the Electrical Trades Union, which was held at Leicester on the 29th ult., it was resolved that there be no wages alteration pending a review of the whole situation in January, 1924. Wages, therefore, will be stabilised at the present scale until February 1 next.

Spain.—A report on the Industries and Commerce of Spain to March, 1923, has just been issued by the Department of Overseas Trade, and shows that there is an improving outlook for the sale of British goods in this great Kingdom. The price is 2s. 2d. net, post free, from H.M. Stationery Office. A similar report on Hungary has also been issued, price 1s. 8d. net, post free, and should interest all English firms who wish to export thereto.

Institute of Transport.—During the week ending June 16 this Institute held a very interesting congress at Sheffield. Some important papers on transport and its various aspects were read and discussed in the mornings, and the afternoons were occupied by visits to several of the leading works in the district, at which members were afforded the opportunity of witnessing the practical application of electric power and transmission in its very latest developments.

Evershed and Vignoles, Ltd.—It will be remembered that the first chairman of this company was the late Professor W. E. Ayrton, F.R.S., who held the position till within a few months of his death in 1908. Since that date the chairmanship has remained vacant. Mr. Sydney Evershed, who has recently retired from the position of managing director, has now accepted the office of chairman, and will, in addition, act as consultant to the company. Mr. E. B. Vignoles and Mr. A. Vines remain managing directors of the company.

Angola.—The report on the trade conditions in this big West African Portuguese Colony has just been issued by H.M. Stationery Office, price 1s. 8d. post free, and gives details of the trade conditions at the end of March, 1923. Sections dealing with telegraphy and wireless will be of interest to some of our readers, and there is also an article on the possibilities in regard to water power which is available from most of the rivers. Electric light is at present being furnished to the towns of Lobito, Benguella and Catumbella.

Siemens' Sports.—The first annual sports and gala of Siemens Bros. and Co., Ltd., will be held on Saturday next, the 23rd inst., from 2.30 p.m. onwards, on the Siemens Sports Ground, Park Lane, Charlton. The programme which has been forwarded to us shows a long table of events which will carry on until about 8 p.m., after which it will be followed by the distribution of prizes and dancing. It looks as if the employees should have a very happy time, and, judging from the photographs of the ground in its various stages of preparation, which adorn the earlier pages of the book, the whole gathering should be a right joyous one. We wish the competitors and their friends the best of good fortune.

The "Meg."—Readers will remember that last October we gave an illustrated description of this new small insulation tester, which was then placed on the market by Messrs. Evershed and Vignoles, Ltd. We are glad to hear from the firm that the demands for this instrument, both at home and abroad, have far exceeded their expectations, and the consequence is they have been kept hard at work executing the orders which have flowed in. To-day we have to thank them for an exceedingly useful reminder of this little instrument in the form of a glass ash tray, in the base of which is a neat advertisement of the instrument which should help to keep its memory green in the minds of all who are fortunate enough to receive one of these handy mementos.

Trade Notes.

A very handsome supplementary catalogue, No. 5, illustrating decorative fittings has just been issued by the **Sloan Electrical Co., Ltd.**, of 8-12, Golden Lane, London, E.C.1. It is a large quarto book of 48 pages and contains details and prices of a very wide and inexpensive range of designs, as well as several new and exclusive patterns, particularly the "Pearlite Acorn One-piece Unit" as shown on page 89, and the new "Silverlite Triplex Glass Fittings" as shown on pages 34 and 35. It will, of course, be of direct value to every electrical installation contractor, and the company will be pleased to send a copy together with showroom introductory booklet to any reader on receipt of proper trade application.

A new catalogue of switchgear has just been issued by the **Foster Engineering Co., Ltd.**, of Morden Works, Wimbledon, London, S.W.19, and should prove of interest to a very wide circle of our readers. The company were the originators of the quick-make and quick-break switches, and the types which they are now placing on the market represent the very latest developments in that particular direction. The list will prove of interest to all central station engineers and installation contractors to whom it will be forwarded on application.

A new special wireless press list of the J.W.B. accumulators has just been issued by **Messrs. Barnard and Haynes, Ltd.**, of 4, Great Winchester Street, London, E.C.2. It contains details and prices of these well-known accumulators which are backed by forty years' experience, and they can, therefore, be recommended for their efficiency and reliability.

"Special Tumbler Switches" is the title of list S.41 which has just been issued by **Messrs. A. P. Lundberg and Sons**, of 477, Liverpool Road, London, N.7. It deals with many of the latest types of tumbler switches in which Messrs. Lundberg have built up such a high reputation, and will, therefore, appeal to every installation engineer and contractor, to whom it will willingly be sent on application. Our readers should most certainly make a point of obtaining a copy without delay.

A catalogue of electric fans has just been issued by the **Sun Electrical Co., Ltd.**, of 118, Charing Cross Road, London, W.C.2. It is well illustrated and gives clear details of the many types of electric fans for which this company has built up such a reputation. It will therefore be of direct interest to all electrical contractors and dealers, to whom it will be sent on receipt of proper trade application.

The Frome Engineering Co., Frome, are issuing leaflets illustrating their .5 kw. lighting and charging set, which is a very compact plant for private-house installation work, and should therefore be of interest to garage owners, electrical contractors and engineers generally who do this kind of work in London and the country. The firm will be pleased to send list and details on application.

Brook-Hirst Switchgear, Ltd., of Northgate Works, Chester, invite readers to an exhibition of their Brookhirst motor control gear, which they have opened at 5, Deansgate, Manchester. The exhibition has been arranged through the courtesy of Messrs. Berry's Electric Co., Ltd., and will remain open until the end of October. The company have also organised a permanent exhibition at their London office, Australia House, Strand, W.C. 2, where London visitors will be most cordially welcomed.

Pamphlet No. 20E, which has just been issued by **Bruce Peebles and Co., Ltd.**, engineers, of Edinburgh, is really a most interesting technical book which will appeal to a very wide circle of readers. The Peebles-la Cour Motor Converters are, of course, well known, and this is a quarto book of 32 pages giving full details of the machine, including the principle of the motor converter, its theory, with fully explanatory workings, the general design and construction, and chapters on starting, operation and advantages. The text is supported by splendidly clear diagrams of windings and connections, so there is no doubt the book will be of interest and use to every electrical engineer who is a user, or potential user, of these machines. We advise all such to write, enclosing trade card, and ask for the pamphlet forthwith.

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A POPULAR SCIENTIFIC WEEKLY JOURNAL
ELECTRICITY
A PRACTICAL TRADE JOURNAL

JUNE 29, 1923.

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CONTACTLESS MOTOR CONTROLLERS.

By F. A. P.

Motor starters and controllers in general depend for their action on the introduction of metallic resistances, to limit initial rushes of current, connected to contact studs over which some form of brush or finger rubs. Although numbers of motors are satisfactorily started in this way, both resistances and rubbing contacts have inherent disadvantages. From time to time other systems have been introduced in order to avoid such troubles as the overheating and sagging of resistances and the wear and sparking occurring at contacts, but generally other troubles have then been introduced. For instance, the ordinary carbon plate pack, the resistance of which is varied by compressing from one end, has been tried, but the sudden and irregular alterations in the movement of the plates have prevented this method from being used practically. Carbon granules and powder or special compositions capable of being compressed to secure the necessary variation in resistance have, however, been used and have had some success. The gradual change in resistance in place of the separate steps required by contact starters give them some advantages, but they do not seem to be as reliable as the latter. This may be owing to the incompressible nature of the particles, reliance having to be placed on the intimacy of contact produced by compression which cannot be reduced gradually. Liquid starters, while useful for large motors and giving very gradual starting, require a certain amount of attention, due to evaporation and so on, which cannot be given to small motors. It would appear, then, that there is still room for some other method, anyway for starting D.C. motors, which would do away with contact studs, and perhaps rely on some automatic increase in the value of the resistance once it is switched into the circuit. In A.C. work at least three methods of this nature have been used, and all, I believe, are patented; they are described here, as their action does not seem to be commonly known. The first is that evolved by Hobart, and depends on the skin effect or the tendency of alternating currents to flow in the outer layers of a conductor by reason of their own inductive effect. It is well known that at high frequencies very little current flows in the centre of a solid conductor, and its apparent resistance is therefore increased, the effect being magnified in magnetic material owing to its greater inductive effect. In experimenting with long iron rods he found that the apparent resistance when the periodicity was increased from 0 to 50 cycles increased more than sevenfold. Now, when the rotor of an A.C. motor is standing and current is switched on to the stator, the currents induced by the rotating field have the full periodicity equal to that of the stator (say, 50); but as the speed increases this falls to a very small amount. At synchronous speed it would be 0, but at full speed—*i.e.*, with the usual proportion of slip—the frequency would be extremely low. If, then, iron resistance rods are arranged in the rotor circuit, the resistance due to the change of frequency between standing and full speed is gradually reduced, the high initial resistance preventing a rush of current, and the lower final resistance allowing the working current to pass. In this way quite automatic starting

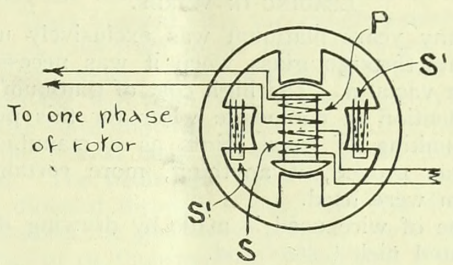


FIG. 1.

can be obtained. Another contactless controller, due to Mr. R. H. Barbour, resembles in its simplest form a 4-pole D.C. motor (Fig. 1). In this form the armature is wound with a primary (*P*) and secondary winding (*S*), the primary connected with one of the phases of the stator, each being separately controlled and the secondary being short-circuited on itself through a resistance. On one pair of opposite poles of the controller are wound one or more sets of secondary windings (*S*1) of different resistance to the moving secondary coil. When in the position shown, the inductive action between *P* and *S*1 is at a minimum and the coil (*S*), which is of high resistance, only has

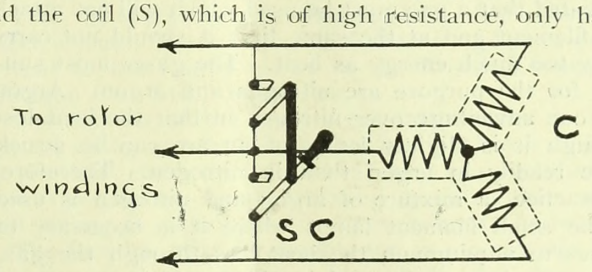


FIG. 2.

effect. Owing to the choking action, a considerable voltage would be required to force current through *P*, and the effect is similar to that of a high resistance connected between the slip-rings of the motor, and so it runs at a slow speed. When, however, the armature is turned through 90 deg., the coils (*S*1) of lower resistance reduce the choking effect, and the full voltage and current is applied to the rotor. Thus,

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without contacts or sparking, control over a range of speeds is obtained. A method of controlling a three-phase motor, depending principally on eddy current effects, is that of Ellipsen, and is shown diagramatically in Fig. 2. *C* is the controller, and is wound similarly to a three-phase transformer, but has solid iron cores, and *S.C.* is a short-circuiting switch to cut the controller out of circuit after starting up. When the stator switch is closed, the impedance produced in the controller coils only permits a predetermined current to flow. The impedance produced is proportional to the frequency of the current induced in the rotor circuit as the motor speeds up, and this, with the strong eddy current effects in the solid cores, tends to maintain the current constant. While the switch *S.C.* may be closed by hand if desired, by means of a relay the whole operation may be made quite automatic once the stator switch has been closed.

MANUFACTURE OF LAMPS.*

(*Concluded from page* 334.)

Leading-In Wires.

For many years platinum was exclusively used to make joints through glass when it was necessary to preserve a vacuum. The high cost of platinum led to the introduction of composite wires for this purpose, and the making of good joints as a manufacturing process has proved, if anything, more certain than if platinum were used.

One type of wire used is made by drawing down a copper-plated nickel steel rod.

The wire is coated with potassium borate to assist the proper wetting of the wire by the glass

A steel is chosen whose expansion coefficient approximates to that of glass, so as to avoid too large a thickness of copper and too large a difference between longitudinal and radial expansion of the composite wire.

An apparatus used to copper-plate the steel rod was developed to ensure a regular and strongly adhesive coating. A poorly plated rod will not draw satisfactorily.

Gas for Gasfilled Lamps.

In considering the theory of the gasfilled lamp, I indicated that a gas must be used which will not attack the filament and at the same time it should not carry away too much energy as heat. The gases most suitable for the purpose are nitrogen and argon. Argon has one advantage over nitrogen in that the heat lost through it is slightly less, but an arc can be struck more readily in argon than in nitrogen. Therefore, in practice, a mixture of argon and nitrogen is used in the small filament lamps where it is necessary to reduce to a minimum the heat loss through the gas, but pure nitrogen is used in the larger lamps where the quantity of gas acquired is considerable and questions of cost arise.

Ordinary air contains 78 per cent. nitrogen and slightly under 1 per cent. argon.

Both these gases are prepared by liquifying ordinary air, and then boiling them off in turn. Nitrogen boils off at — 196 degrees Centigrade, the argon at — 186 degrees Centigrade, and the oxygen is mainly left behind as liquid, as it does not boil until the temperature reaches — 182 degrees Centigrade.

Both the nitrogen and the argon contain oxygen, the bulk of which is removed by burning hydrogen in the gas. The last traces of oxygen are eliminated by passing the gas over heated copper. Carbon dioxide and water vapour are present at this stage, and these are removed by passing the gas over the usual caustic soda and phosphorus pentoxide chemical agents.

It is essential that these impurities be removed as they rapidly destroy the filament, and this will be referred to later.

Tungsten.

Tungsten filaments are made from an ore called scheelite, which consists mainly of a compound of calcium, tungsten and oxygen.

I will not weary you by following in detail the chemical processes by which practically pure tungsten metal powder is obtained from the scheelite. It is sometimes desirable to add small quantities, up to 0.5 per cent. approximately, of other materials to the tungsten powder in order to get specific characteristics in the final product, shown in slide, bedded in copper. A definite weight of metal powder is placed into a steel mould and pressed into an ingot. A section of such ingot is shown.

It has none of the characteristic crystalline structure of a metal, and voids are still visible.

The ingot at this stage is very fragile and could not be picked up in the middle.

It is next heated in hydrogen to 1,200 degrees Centigrade, to give it sufficient strength to stand handling.

The ingot is then heated to near its melting point. During this process the particles of powder link up to form the crystalline structure shown in slide.

The ingot is now quite strong, but very brittle.

The corners are ground off the ingot, which is again heated to 1,350 degrees and subjected to hammering processes, called "swaging." This process reduces the diameter of the rod and increases its length, and is continued until the diameter is slightly less than 1 mm. and the length about 50 feet.

During this process the grains get more and more elongated in the direction of the length of the wire, giving rise to a fibrous structure, and the material attains considerable ductility.

The swaged wire is now drawn through diamond dies in steps of about 10 per cent. in diameter down to the 0.015 mm., or about half a thousandth of an inch.

Anyone who has tried drilling good circular holes in brass or steel of this diameter will realise what is entailed in drilling a similar hole through diamond.

The threading of these small wires through the dies is not achieved the first few hundred attempts, and it is reported by the works manager that in the early days of tungsten filament manufacture it was only possible to keep up the courage of the girl operators by a liberal supply of chocolates.

Slides indicating the changes that go on in the filament during its life were then shown.

In conclusion, we will consider the possibilities of further improvement in the future.

* Paper read by Bernard P. Dudding, Esq., before the National Association of Supervising Electricians.

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Owing to the rapid wasting of the filament in vacuum at temperatures much in excess of the present operating temperatures of vacuum lamps, it appears that only small improvements in this type of lamp can be expected.

The highest efficiency of light production attainable by the use of tungsten as a filament is determined by the temperature at which it can be operated in a gas so as not to cause serious wastage of the filament in the economic life of the lamp (about 1,000 hours).

This occurs at about 2,650 degrees Centigrade, when the efficiency of the lamp would be in the neighbourhood of half a watt per average candle.

It is not possible at the present time to attain this ideal, particularly in small wattage lamps, because the filament is not strong enough to support itself when wound in the form of a large diameter spiral, which form, we have seen, is necessary to the production of an efficient lamp.

Mr. Dudding then exhibited and explained the numerous pieces of apparatus and samples.

Discussion.

The President, throwing the meeting open to discussion, said that the Association were that evening indebted to Mr. Dudding for an intellectual treat, not only in the lecture, but in the exhibition of the numerous samples on view.

The evolution of the electric lamp was as romantic as any fiction writer could have devised. Its present state of perfection illustrated extraordinary ingenuity and years of unwearying research. It had culminated to-day in the scientist, the chemist and the metallurgist being welded into a perfect whole. The continuity of success depended upon the interdependenc of every department.

The production of the electric lamp had undoubtedly received the approbation of the electrical industry as a whole, and it was significant to remember that the cost of electricity had not been even temporarily increased. The low-power consumption lamps were introduced, although the load on many stations had probably been divided by two. This was all to the good of the industry, and to-day matters had adjusted themselves because we had all learned to use more light.

Mr. W. Burton, opening the discussion, referred to many makes of lamps, and gave his opinions gained during his experience as a user.

Mr. W. J. Revell suggested that we were getting increased light and lower current consumption in the modern types of lamps at the expense of life, as carbon lamps undoubtedly lasted longer, if not so efficient. He inquired the purpose of the mica shield in lamps; also, if gas were used at all in the so-called "half-watt" lamps of Dutch origin.

Mr. H. A. Manning recalled some of the features of the Nernst lamp, and asked if this lamp had really been surpassed or suppressed.

Mr. G. P. Garbett said they had heard much of the scientific side of lamps, but he thought some tribute was due to the commercial side also. He would like to hear from Mr. Dudding why the small candle-power lamps were not so efficient, and why the life was not so good; also, why a satisfactory lamp was not produced for use in horizontal positions. What was the secret of the "half-watt" lamp of to-day? Is it a fact that the "half-watt" theory and its attendant calculations are a fallacy?

Mr. T. H. Windibank mentioned the neon lamp and some of its recent developments, and asked if Mr. Dudding, in view of the high efficiencies claimed, could offer any information as to its future, and whether it would possibly be developed to oust the incandescent lamp.

Mr. H. Wallace asked if it were detrimental to the larger candle-power metal filament lamps to switch them on direct across the line. The rush of current was considerable, and he would like to know if switching on and off through a resistance would not be preferable.

Mr. Dudding, replying, said: The correct modern term to use is "gasfilled," not "half-watt," and this is now found on practically all commercial lamps. The Continental lamp was no better than the English lamp, and the "half-watt" description was untrue. From the H.V. 60-watt lamp upwards, the gasfilled lamp was a distinct advance upon the vacuum type. The H.V. 40-watt was only slightly better than the vacuum. Manufacturers, however, favour the gasfilled type, and claim that the whiter light enabled them to see detail better. Tests showed that the candle-power of gasfilled lamps falls from 10 per cent. to 20 per cent. in a life of 1,000 hours. The mica shield is used in lamps to protect the seal from heat. Argon gas is not used in its pure state above 80 volts. For all ordinary purposes, the Nernst lamp is replaced by the focus type, gasfilled. The neon type lamp is one in which current is directed through a gas, and the disturbance set up causes the gas to emit light. It is at present only efficient in thousands of volts, and the types at present in use included a resistance in the cap which considerably reduced the efficiency. It undoubtedly has a very interesting future.

There was no apparent necessity for resistance in switching in the large candle-power lamps, judging by the life test rack experience in the laboratories.

A vote of thanks to Mr. Dudding was ably proposed by the general secretary, Mr. A. Brammer, to which Mr. Dudding suitably responded.

A VISIT TO THE BRITISH THOMSON-HOUSTON COMPANY'S WORKS, RUGBY.

The members of the Birmingham and District Electric Club, by the courtesy of the management, paid a visit to the Rugby works of the British Thomson-Houston Co., Ltd., on June 20.

The saloons of the party were taken direct to the special siding attached to the works; lunch was served in the staff canteen, after which they were conducted over the various departments by special guides able and willing to explain the firm's multifarious activities.

The foundry, with its moulds for 40-ton castings for the large generator sets, for which the firm are famous, the controller shops where electric traction apparatus of all kinds, for all parts of the world, were in process of construction, and turbo-generators for many of the new central stations, all were examined with great interest; automatic apparatus for the remote control of sub-stations was the subject of very special attention; lastly, after an early tea, the polite and efficient lightning conductors took the party over the "Mazda" Lamp factory, which, with its elaborate

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automatic glass working and other machinery, leaves one wondering how long it will be before human hands atrophy from lack of use. There were, however, other parts of the lamp works where, by watching the deft fingers of the girls, one's confidence in human survival was restored.

To be royally entertained by the British Thomson-Houston Company, who do not allow their engineering enthusiasm to interfere with their hospitality, and to see over their great Rugby works in one half-day is something of a breathless experience, but one which none of the members would willingly have missed.

THE "USCO" WATER-SLUICE ASH CONVEYOR.

(FROM A SPECIAL CORRESPONDENT.)

There is now being installed at the St. Pancras Electricity Station by Messrs. The Underfeed Stoker Co., Ltd., of London, an ash conveyor on the water-sluice principle, which promises to effect something in the nature of a revolution in ash conveying. As is well known, the mechanical conveying of ash and clinker is one of the most unsatisfactory operations in the whole field of power generation, because of the hard and abrasive character of the material, and more particularly because of corrosion, so that the wear and tear and depreciation on any ordinary ash conveyor is extremely severe, probably three or four times as great as that of coal conveying.

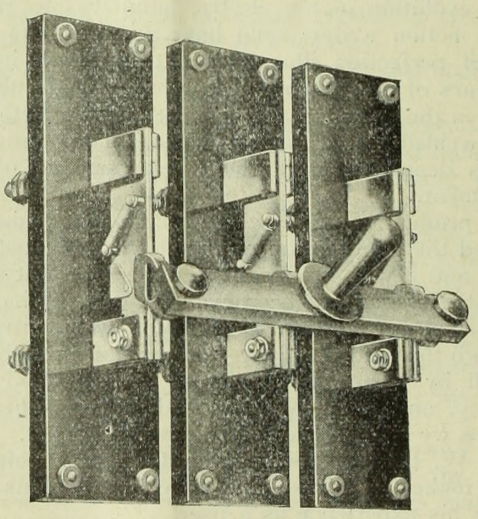
The boiler plant under consideration at St. Pancras Electricity Station consists at the present time of two water-tube boilers of 40,000 lb. evaporation each, and two other boilers now in course of erection, forming one line of four boilers.

The ash and clinker drops over the end of the stokers, totally enclosed, into heavy cast-iron ash hoppers, which dip down into an entirely enclosed concrete trough underneath, forming the water sluice. This trough is semi-circular in section, with an internal width of about 1 ft. 6 in. and a depth of about 2 ft. 6 in., and runs underneath the boilers common to all the ash hoppers. Rushing along inside this trough is a volume of water at a constant depth of about 6 in., with a flow volume of 600 gallons per minute, which passes into a large underground concrete ash discharge pit.

In the near future another row of four 40,000 lb. boilers will be erected, which will be served by a similar trough, and both troughs are equipped with one main pumping installation, which pumps the sluice water from the ash discharge pit, passes it to the other end of the troughs, along which it flows to the pit again, forming a completely closed circuit with a very rapid flow of water. The power required for the whole eight boilers will only be one centrifugal pump of 16 h.p. running at 936 revs. per minute, with a total flow of water in the closed circuit of 1,200 gallons per minute, so that the power required is infinitesimal. The red-hot ash and clinker drops into the flowing water, is quenched at once, and swept along and discharged into a large concrete tank, where it falls to the bottom, the water passing back to the centrifugal pump through strainers. As the ash and clinker accumulates, it is removed from time to time by a large telpher grab, and the whole system is extremely simple, neat and efficient. In addition to the small power required, there is also a number of other advantages, chief of which is the almost entire absence of wear and tear, since there is nothing to go wrong. Also the whole arrangement is totally enclosed, so that there is no dust or dirt, no heat, and particularly no escape of foul-smelling steam, whilst the ash and clinker, as soon as it falls into the comparatively cold water, at once breaks up into extremely small pieces. Another curious fact is that in the presence of a large bulk of water in this way the material is alkaline, in spite of the fact that ash and clinker, when quenched with a small amount of water in the ordinary way, is distinctly acid. The amount of make-up water required in the total circuit is very small, and the temperature does not rise much above 140 deg. F.

AIR-BREAK KNIFE SWITCHES.

It is gratifying to observe that, so soon after publication of the British Engineering Standards Association's Specification No. 109/1923 for Air-Break Knife Switches, a range of this apparatus has been placed on the market. It is only by the active co-operation of manufacturers in this manner that the full advantages of the arduous work of the Association can be secured. Messrs. Henley's have sent us a catalogue describing in detail a complete range of air-break knife switches to this specification, and readers will find it a handy list for reference.



They are of neat design, robust construction, and are made from the best materials. Long flicker blades, fitted with substantial springs, are provided to give a rapid break. They are arranged so that when the flicker breaks it is parallel with the edge of the break contact, thus minimising the effect of the arc. Mounted switches are provided with black enamelled slate bases of best insulating qualities, free from metallic veins and other defects.

Our illustration shows one of the triple-pole, single-throw angle type, 660 volts.

Plant for Sale.—Readers who are on the look-out for good second-hand electrical plant will be interested in the advertisement appearing in our prepaid columns this week, announcing the sale of electric light and power plant at Duff House, Banff, N.B.

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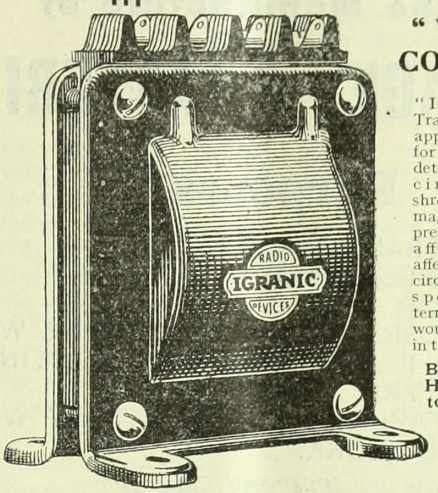
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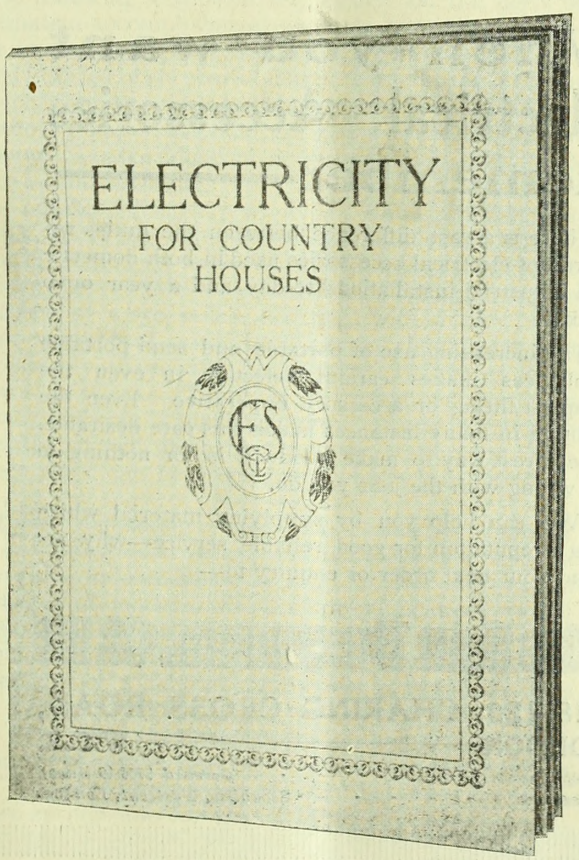


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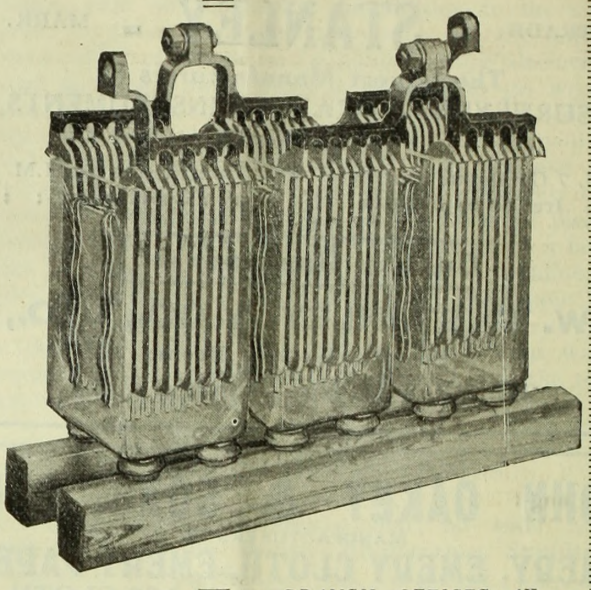
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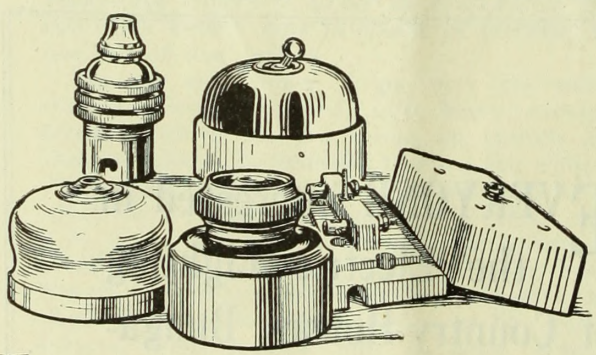
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TO OUR READERS.

ELECTRICITY is published every Friday, and, if ordered, is on sale at the principal Railway Station Bookstalls and Newsagents on that day. It has a very large sale throughout the United Kingdom, as well as in the British Colonies and Abroad.

New advertisements for the displayed columns and alterations to existing ones must reach the publishing office not later than first post Tuesday morning, in order to be in time for the issue of the following Friday. This is important. Rate quoted on application. Subscription: 13s. a year, 6s. 6d. half year, 3s. 3d. a quarter in advance, postage prepaid in the United Kingdom and abroad.

Questions to which an answer is required must be accompanied by a 1½d. stamp for reply. When considered of sufficient interest, the answer will probably appear in the paper.

All remittances payable to the Publishers, S. RENTELL AND CO., LTD., 36-39, Maiden Lane, London, W.C.2. Telephone No. 2460 Gerrard.

Current Topics.

Low Power Long-Distance Wireless.

Regular readers will doubtless remember my comments on the successful experiments in long-distance wireless telephony conducted by an enthusiastic amateur radio society. I remarked at the time that the results then obtained tended to demonstrate the possibility of greatly reducing the power and the wavelengths used by the large trans-oceanic wireless stations for transmitting commercial messages, and I congratulated the amateurs upon their enthusiasm and the success which had attended their efforts. If I remember aright, it was then tendered by way of explanation from the experts that, although successful in this particular instance, the combination of low power and short wavelengths was inapplicable to commercial wireless, because it would not prove sufficiently directive or reliable to ensure successful transmission at all times of the day or night and throughout all seasons.

Yet, following comparatively closely on the heels of this amateur accomplishment, comes a general announcement in the Press that Senator Marconi has just conducted a series of successful experiments during a trip in his yacht *Electra* which foreshadow much cheaper wireless and a general speeding up in transmission. In an interview, Senator Marconi is credited with such statements as the following:—"The tests have resulted in some notable discoveries. It is now possible, for example, to do big distances with a very small amount of power compared with what is necessary with the present system. We have transmitted messages up to a distance of 2,250 miles, not only with a very much smaller amount of power and energy, but faster and more cheaply than with the ordinary system of long-distance wireless. There is a great increase in efficiency and cost is much reduced. When this system is adopted, it will mean that a power station for long-distance work can be erected at a much less cost."

Without detracting from the value of Senator Marconi's latest discoveries, and with due deference to the world's indebtedness to him for the inestimable advantages of modern wireless communication, would it be too much to ask whether these latest successes are in a measure due to the purely voluntary and enthusiastic efforts of a few amateurs only a month or two back? Technical details of the new system are lacking, but it does seem that the advent of broadcasting and the enormous public interest in wireless experimenting which has been stimulated thereby has been in some measure responsible for the rapid strides made in professional wireless development, and, if this is so, no doubt Senator Marconi would be the first to give credit where it is due.

Electrical Cremation.

A novel, if somewhat gruesome, application of electric heat is suggested in a report from India, where a Parsee society is credited with having made application to the Bombay Corporation for the grant of a site for the erection of an electrical crematorium. The Parsee method of disposing of their dead is by placing the bodies on what are locally known as Towers of Silence, on the outskirts of the city, and where they are exposed to the attacks of vultures and other birds of prey which speedily consume the remains. For many years there has been a growing feeling among the more modern and advanced Parsees that a more sanitary and less objectionable method was desirable, yet one which was calculated not to offend the lower orders of their religion.

Under the Parsee faith fire is considered sacred, and the Hindu method of cremation by ordinary means was therefore not permissible. It is thought that a solution of the difficulty has now been found in the electrical crematorium which, while disposing of the remains reverently and hygienically, does not immediately defile the sacred element of fire. If the scheme attains fruition it will constitute a marked advance in religious toleration, for there are few more jealous of the observances of their faith than the various native tribes of India, among whom superstition still holds strong sway. Incidentally the proposal suggests possibilities of electrical cremation in this country as providing a more readily controllable, and possibly more rapid, system for the disposal of our own departed.

The Gospel of Domestic Electric Service.

In his presidential address to the Incorporated Municipal Electrical Association's Annual Conference at Scarborough, Lieut.-Colonel Vignoles, D.S.O., chose as his text the urgent need for still further educating the public up to electric service in the household. The time was opportune for a campaign against the public. The consumer, although he might not yet be aware of it, wanted electricity because it would save labour for his womankind, and because he wanted the cleanliness that could not be obtained by any other method of lighting or cooking. Further, people now building houses and bungalows wished to save first costs by cutting out chimneys and flues and provide for electric cooking. By catering for this need the Association could assist in the solution of the housing problem. Beyond this electricity had a great mission to carry out, a mission to improve the health of the people and to reduce the drudgery of housework.

Electricity could be a great benefactor to the human race, giving the householder a pure atmosphere to live in, an easy means of cooking under perfect conditions, reducing waste of food, and making the lives of those who do their own housework more endurable. It was the duty of the Association to educate the public in both the uses and the vast advantages of electricity. The fringe of the field had barely been touched; the harvest to be reached was enormous. If only 25 per cent. of

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the possible business, which might easily be 200 to 3,000 units per house, was secured, the effect on working costs must be considerable, making a price of ¼d. to ½d. per unit possible, with a corresponding increase in prospective business. But to secure this business to every undertaking it was not sufficient for the individual concerns to lower their prices and hope for results, erecting a sign: "We supply electricity for heating, cooking or cremating." The public must be taught, told, reminded, shown, and told again how to use electricity.

Colonel Vignoles could not have chosen a better subject for his appeal to this representative gathering of municipal supply authorities. He might even have been less polite and taunted them with neglect of duty, for, although there are many enterprising supply departments, there are a greater proportion of undertakings whose sponsors are too apathetic or disinclined to tackle the domestic load, promising as it is. There are certain municipal undertakings I could name which, if they only took all the business which offered, in the shape of new would-be consumers, without going to the small additional trouble and expense of canvassing the various householders in their area of supply, could add quite a respectable revenue to that they already derive from a comparatively small number of large consumers of power

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The trouble in most cases is that the domestic load is regarded by the big-station men as not worth while, and not warranting the necessary expenditure on new mains and extensions. Why go to the householder—they argue—when we can get all the load we want to be bothered with from the tramways and works in the neighbourhood? That, I fear, is the attitude of a good many of the larger municipal undertakings, who are not catering for the ratepayers, whose servants they are. If domestic electricity supply is to make headway in this country, the municipal undertakings as a whole will have to work very much harder in that particular direction than they have done in the past quarter of a century. There are literally thousands of would-be consumers to-day who are well aware of the advantages of electrical service, but who cannot obtain a supply for their households on reasonable terms due to the lack of service mains or the apathy of their local undertakings.

ELEKTRON.

B.E.X.

"Public Electricity Service" is the title of a charmingly printed booklet which has just been issued by Mr. J. W. Beauchamp, the enterprising director of the Electrical Development Association. The idea is to gain the financial support of all the electricity supply undertakings of the United Kingdom, whether municipal or company is immaterial, with the object of putting up in an important position within the B.E.A.M.A. section of the British Empire Exhibition a general display of an attractive and educational character on behalf of and paid for by the said electric supply undertakings.

The proposition is one which should have the most enthusiastic support of everybody who is in any way connected with the electrical industry, which it would do so much to benefit, and it is to be hoped that it will quickly receive the financial backing which is necessary. The booklet should go a long way towards convincing those who control the purse strings that the object aimed at would be of benefit in causing an all-round increase in the demand for current.

By the way, it is suggested that we might try to get everyone to refer to the British Empire Exhibition generally as the B.E. "X." instead of the B.E. "E.," and we have headed this article accordingly.

THE USE OF RUBBER PRODUCTS AS DIELECTRICS.*

BY W. S. FLIGHT, A.M.I.E.E.

A CONSIDERATION OF SOME OF THE MOST IMPORTANT FUNDAMENTAL CHARACTERISTICS OF DIELECTRICS.

Since the early days of the electrical industry the insulating properties of rubber have rendered it of value for use as a dielectric. The various applications of rubber in this connection may be classified as follows:—

(*a*) As a flexible covering for wires and cables.

(*b*) As a hard composite, such as ebonite.

(*c*) Miscellaneous applications, such as: (i) a flexible material for use as gloves, insulating mats, etc.; (ii) rubber latex for the manufacture of insulating papers and boards; (iii) chlorinated rubber for use as a varnish, etc.

The study of the use of rubber as a dielectric in all the above forms is too wide to come within the scope of a single paper, and the present paper purposes mainly to deal with the use of rubber products in the form of hard composite dielectrics.

It is proposed first to review briefly some of the most important properties of dielectrics before considering in detail the use of rubber products in this connection.

DEFINITIONS AND GENERAL CONSIDERATIONS.

A dielectric may be defined as any substance, either solid, liquid or gaseous, which offers a very high resistance to the flow of electricity. There is no known substance which is a complete insulator of electricity, although in the case of the best dielectrics the current which flows through the material at low voltage stress, *i.e.*, at low electrical pressures, cannot be measured by even the most sensitive methods.

The complete study of the electrical characteristics of a dielectric involves an investigation of electric strength, volume resistivity, surface resistivity, permittivity and power factor.

These properties of a dielectric will now be briefly considered.

ELECTRIC STRENGTH.

Electric strength is now the recognised term for that property of a dielectric which was previously known as its dielectric strength.

The electric strength of a material is the stress expressed in terms of volts per unit thickness[1] required to produce electrical breakdown of the material. In some respects the electric strength of a dielectric is analogous to the tensile strength of structural materials; but, as will be shown later, its value is influenced by so

* Abstract from paper read before the Institution of Rubber Industry.

[1] This is analogous to stress per unit area, *e.g.*, lbs. per square inch in considering mechanical strength.

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many factors that it is necessary that the conditions under which the electric strength tests are made should be accurately defined in order that the results obtained may be of any practical value. In investigating the suitability of any material for use as a dielectric a study of the electric strength under various conditions is of the greatest importance, and this test is in general employed to a greater extent than the other electrical tests mentioned.

VOLUME RESISTIVITY.

Volume resistivity is the resistance of the bulk of the material, and is expressed in terms of the resistance between opposite faces of a cube of unit side. For insulating materials it is usually recorded in terms of megohms [2] per unit cube, such as a centimetre cube. A knowledge of the volume resistivity of a material enables some idea of the magnitude of the leakage current through the material to be obtained for various applied voltages. It has been shown [3] that unlike metals and other good conductors of electricity, the current which flows through an insulating material is not directly proportional to the applied voltage, but increases at a greater rate than the applied voltage. In consequence of this it is necessary to state the voltage at which the resistivity of dielectrics is measured.

SURFACE RESISTIVITY.

Not only does electricity leak through insulating materials, but it also leaks across their surface. The surface resistivity is defined as the resistance between opposite edges of a surface of unit length and width, such as two edges each 1 centimetre placed 1 centimetre apart on the surface of the material.

PERMITTIVITY.

Whenever a dielectric is subjected to an electric stress some of the energy supplied is stored in the insulating material. It is this property of dielectrics which renders possible the construction of electrical condensers. The capacity of a given size of electrical condenser depends on the permittivity of the dielectric employed in its construction, and the permittivity of the material may be defined as the ratio of the capacity of a condenser made with the dielectric to that of a condenser of exactly the same dimensions, but employing air as the dielectric. When this property is measured under carefully defined conditions a particular value is obtained which is known as the dielectric constant or specific inductive capacity of the material.

In other words, the permittivity of a dielectric is a measure of the electrical energy which unit cube of the material can store as electro-static energy. This property of dielectrics is of considerable importance when the material is intended for use as condensers for which purpose a high permittivity is required, and also when the material is employed for insulating wires and cables when a low permittivity is usually desirable.

POWER FACTOR.

The capacity current which flows into a condenser when an electrical pressure is applied to the dielectric represents a storage of electrical energy which is analogous to the energy stores in a spring when the latter is subjected to a mechanical pressure. If the pressure be released, the spring will give back most of the energy used to compress it, and if the direction of the force be reversed so that the spring is stretched instead of compressed, a similar storage of energy takes place again. The above analogy represents the action of a dielectric when subjected to an alternating electric stress. Each time the electrical pressure is applied in either a positive or negative direction the dielectric stores up energy, most of which is given back to the circuit when the pressure is removed or changed in direction.

Due to friction losses in the mechanical analogy, the spring cannot give back quite as much energy as was delivered to it, so in the case of dielectrics there are losses the exact nature of which is not fully understood, but which may be considered as a friction loss, inasmuch as they cause heating of the dielectric and result in less energy being returned to the circuit than was delivered to the condenser.

The power factor of a dielectric is the ratio expressed as a percentage of the energy dissipated in the dielectric to the total energy supplied to the dielectric. For example, if when 100 volt-amperes are supplied to an ebonite condenser there is a total dielectric loss of 5 volt-amperes, the power factor of the ebonite would then be 5 per cent.

[2] One megohm equals 1,000,000 ohms.

[3] *J.I.E.E.*, Vol. 52, p. 51, "The Characteristics of Insulation Resistance," by S. Evershed.

Questions and Answers by Practical Men.

RULES.

QUESTIONS: *We invite our readers to send us questions, preferably on technical problems that have arisen in actual practice. Questions which we consider of sufficient interest to our readers will either be replied to under "Answers to Correspondents" or replies will be invited from our readers. One shilling will be paid for the question which we select for competitive replies in this column.*

ANSWERS: *A fee of 10s. will be paid for the answer which we consider shows the greatest merit, and 5s. for the one we select as second best. In judging the replies, importance will be attached to clearness and conciseness, as well as accuracy. The Editor reserves the right to make no award, or to accept only one reply, if, in his opinion, the answers received do not possess sufficient merit. Competitors desiring the return of their manuscripts, if unaccepted, should enclose stamped addressed envelope.*

Write on one side of the paper only, and if diagrams are sent, draw them on a separate sheet of paper attached to the manuscript. Competitors may adopt a "nom de plume," but, both in the case of questions and answers, the competitor's real name and address must be sent with the manuscript as a guarantee of good faith. No correspondence will be entered into with regard to successful replies. The Editor's decision is final.

Commencing with Question No. 101, a Diploma of Merit will be awarded to the six competitors who win the first or second prize the most times during the next twelve months.

The words "Questions and Answers" or "Q" and "A" should be placed at the top left-hand corner of all letters intended for this column.

QUESTION NO. 161.

Are there any hard and fast rules for the earthing of motors? The other day one of my motors, 10 b.h.p., 440 volts D.C. 3-wire, developed an earth. To my surprise, the earth wire, connected from the motor to the conduit, fused. This wire was about $\frac{1}{8}$ in. copper. As this was evidently not strong enough, what wire should be used?—"EXAMINER."

QUESTION NO. 162.

Can any reader give me details of the facts which govern the choice of high-tension insulators? I have heard talk of "Corona effect." What is this? Does it affect insulators used on voltages of over or under 6,600 volts?—"JOINTER."

(Replies to Questions Nos. 161 and 162 must be received not later than June 30, 1923.

Answers to Questions.

QUESTION NO. 158.

I have to repair a number of accumulators. My difficulty is that I do not know how to connect the

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bridge pieces, that is, the bars which are connected across the top of each set of plates. I understand that these are "burnt" on. How is this done?—"ACCUMULATOR."

REPLIES TO QUESTION NO. 158.

The first prize (10s.) has been awarded to "M. M." for the following reply:—

Burning would certainly be the best method of making the joints, but some practice and skill, plus rather elaborate apparatus, are required to ensure the results being satisfactory. For lead-burning a small oxy-hydrogen flame is used, and it must be carefully adjusted. Flame is best when the point is very hot. It should turn a violet colour when melting a piece of clean lead. Oxygen is purchased in cylinders; hydrogen is either taken from a gas main or generated by the action of dilute sulphuric acid on scrap zinc. If joints are butted, chamfer edges so that the grooves formed will be an assistance when making the joint. Feed in the necessary lead from a strip of lead. All parts must be perfectly clean.

In the case under consideration there will probably be a further difficulty in having to do the work *in situ*; but, even if it is possible to lay the parts horizontally, "Accumulator" should experiment with a few joints before tackling the plates.

If it can be arranged, it is much easier to have a mould made for the joints and simply melt them together, either by flame or by means of a well-heated "bit."

Another method is to "shave," or scrape, the joint perfectly clean, well heat with a blow-lamp, tin and "wipe "together with plumber's solder (2 lead + 1 tin) by means of a piece of greased moleskin.

Perhaps the most convenient way will be to electrically weld the joints. A carbon rod for positive and the joint for negative. Feed in lead from a clean strip as required. A little practice on some scrap material will soon overcome any want of skill.

With any of the above-mentioned it would fill a number of ELECTRICITY to describe any one in detail. Should the resulting joints be somewhat rough in appearance, they may be easily dressed up by means of a rasp.—"M. M."

The second prize (5s.) has been awarded Mr. G. Sullivan, 45, Elmswood Road, Birkenhead, Cheshire, for the following reply:—

To burn connections on, say, 100-ampere battery, the following method is reliable and simple. The material required is a sharp knife, some clay, tin of fluxite, some strips of lead about $\frac{1}{8}$ in. by $\frac{1}{4}$ in. to use in place of ordinary tinman's solder (which eats away in acid), and a good-sized soldering iron, which has been well tinned with tinman's solder. Proceed: Clean and scrape bright surfaces to be joined together, care being taken to clean round and well back so that only the bright lead surface is exposed. Foreign matter is fatal to lead-burning. Now take the pieces to be united and, with a clean stick, apply a thin coating of fluxite to the prepared surfaces and secure them together—it is sometimes best to cut a V-notch in one for the other to fit in—then apply some clay round the edges of the pieces to be burnt together to form a cup to enable the hot metal to run together and keep at the right level. Now take soldering iron, heated just under sufficient to burn tinned face, and apply it to the two surfaces to be joined, the object being to make them run together, at the same time having ready a strip of lead dipped in fluxite. Apply to the iron in a manner similar to ordinary solder. This will help to raise the molten metal to the proper level. Allow to cool, break away clay, and clean up with a fine rasp or coarse file.—G. F. SULLIVAN.

THE ROTHERHAM POWER STATION.

The increasing demand for electrical power in the Rotherham district, due chiefly to the rapid growth of steel works and similar undertakings, has necessitated the building of a new power station to supplement, and eventually replace, the old generating station in Rawmarsh Road.

This new station, which was formally opened by the Prince of Wales on May 28 last, has been laid out under the direction of Mr. Edward Cross—the Engineer and General Manager of the Corporation Electricity Supply Department—to deal with an ultimate plant capacity of 125,000 kw. This will include four sections of switchgear with bus-bar reactances between them, but at present only two sections are installed, one of which includes the control of two Parsons 12,500 kw. turbo-generators, and the other a B.T.-H. 30,000 kw. turbo-Generator.

Auxiliary plant is supplied from two B.T.-H. 1,500 kw. rotary converters running at 500 r.p.m., converting from 6,600 volts 3-phase to 480/520 volts D.C. An interconnector between the old station and the new permits an interchange of 5,000 kw. between the two, so that continuity of supply is assured in the event of one of the stations being shut down. With a further view to ensuring continuity of supply all the H.T. switchgear is arranged with duplicate bus-bars.

Probably the most interesting feature of the whole plant is the turbo-generator, which is the largest single power generating unit installed in the United Kingdom. This turbo-alternator, of which we give an illustration, was designed and constructed by the British Thomson-Houston Company, Ltd., and has a continuous output corresponding to 40,000 h.p., the generator giving 30,000 kw. 3-phase current at 6,600 volts, 50 cycles, its speed being 1,500 revs. per minute. The turbine is of the Curtis type, with 14 stages, the first stage wheel having two rows of blades and the remaining 13 wheels one row of blades each. The largest wheel is 12 ft. diameter. The generator is of the totally enclosed, air-cooled type, and is coupled direct to the turbine by a flexible claw coupling. The total weight of the turbo-generator is about 300 tons, and the space occupied is approximately 47 ft. by 20 ft. 6 in. floor area by 12 ft. above floor level.

The steam turbine was erected on the test bed at The British Thomson-Houston Company's Works in Rugby, and weighs 145 tons. Owing to the limitations of the British railway loading gauge it was necessary to remove several of the largest wheels before despatching the steam rotor, and to reassemble them on site. For the same reason the electrical stator had to be despatched in parts and erected on site.

THE ELECTRICAL END.

The alternator is designed for a miximum continuous output of 40,000 kVA, 3 phase, 1,500 r.p.m., 6,600

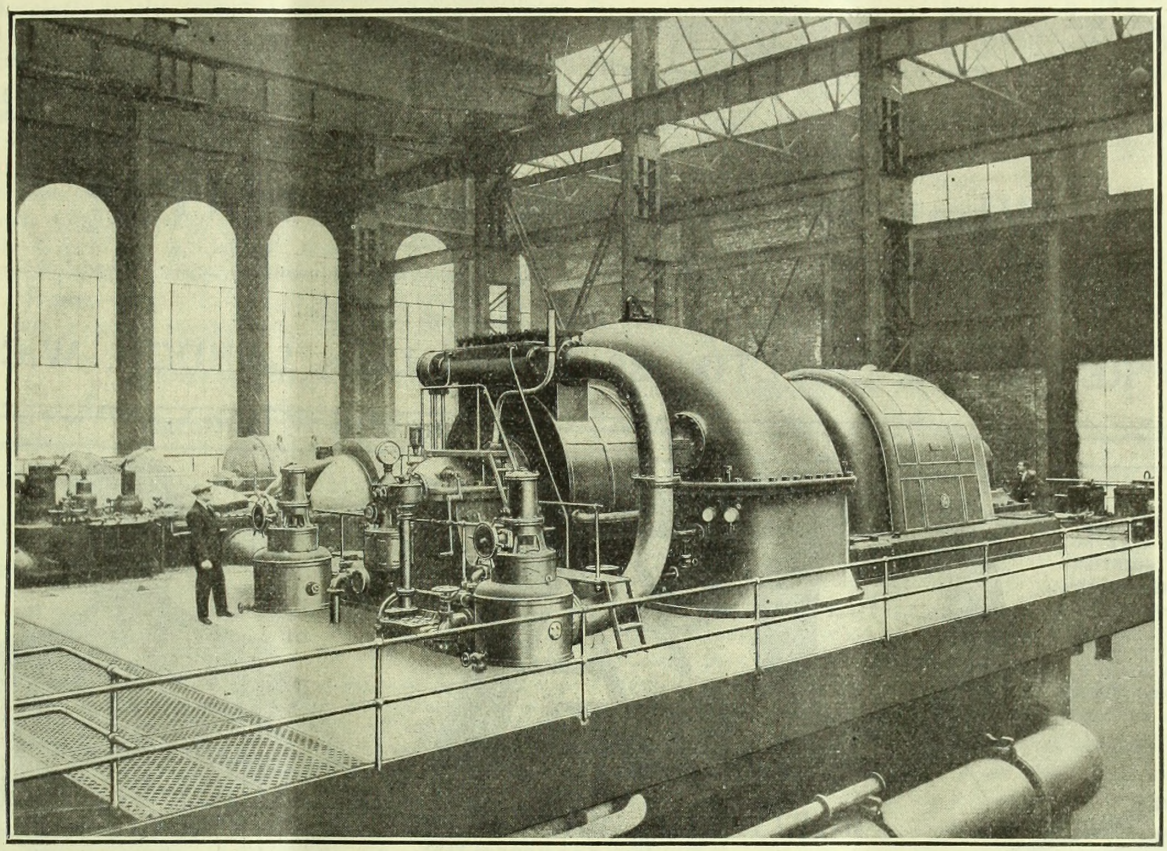
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volts, 50 cycles at a power factor of 75 per cent., i.e., 30,000 kw. It is of the totally enclosed, air-cooled type, direct coupled to the turbine and provided with a direct coupled exciter.

The stator frame is of cast iron, divided into halves vertically. The section is of the box type, strongly ribbed, the space between the outer and inner shells serving as a passage by which the air, after ventilating the machine, is conducted to the exit duct. The frame is provided with detachable planished steel over the outside openings to facilitate inspection. The stator core laminations are constructed of high resistance, high permeability steel, both sides of which are coated with an insulating enamel so as to reduce eddy current losses to the lowest possible value. The laminations are in the form of segments, and are provided on their outer circumference with dovetail slots for the keys, and on the inner circumference with slots for the reception of the windings. The segments are assembled in the frame so as to break joint in successive layers. The stator winding is of the bar type, arranged in two layers, in open type slots. The slots have openings shaped to accommodate dovetail section keys of impregnated hard wood, which hold the windings securely in position. The stator windings were subjected to a high potential test of 14,200 volts for one minute, both to earth and between phases, before the machine was put into service.

The rotor is of the cylindrical non-salient pole type with distributed windings. There was no difficulty in transporting the rotor, and this was, therefore, constructed complete at the works, thus enabling running balance, overspeed and insulation tests to be carried out before despatch. The rotor is designed with its critical speed below the normal running speed, i.e., approximately 1,000 r.p.m. In order to allow of running through this speed with safety and freedom from excessive vibration, the shaft journal at the exciter end is carried in a special "slip" bearing. This is arranged to permit of a small radial play between friction collars, and the radial movement thus allowed when running through the critical speed with the resulting work which is done on the friction collars completely destroys any tendency to "whipping" of the shaft. The complete rotor was subjected to a high potential test of 1,500 volts for one minute when running at 15 per cent. above its normal speed.

The alternator is designed to be self-ventilating in accordance with B.T.-H. standard practice, thus dispensing with the use of external fans. The stator is provided with double end shields and shrouded fans are attached to each end of the rotor for creating the necessary draught. The ventilating air is drawn into the machine by the rotor fans through suitable ducts in the foundations at both ends of the machine. On entering the machine between the double end shields, part of the air is drawn into the rotor, cooling on its way the end windings, the remainder passing through the fans into the space enclosed by the inner end shields, in which are situated the stator end windings. The air which enters the rotor is distributed along the entire length, and is expelled through the various radial air ducts into the air gap. The air from the stator end shields, after

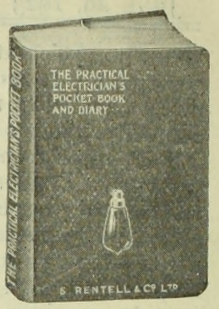


B.T.-H. 30,000 KW. TURBO-GENERATOR IN ROTHERHAM POWER STATION.

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571 pages of Text, Tables and Data

"IT"—THE PRACTICAL ELECTRICIAN'S POCKET BOOK



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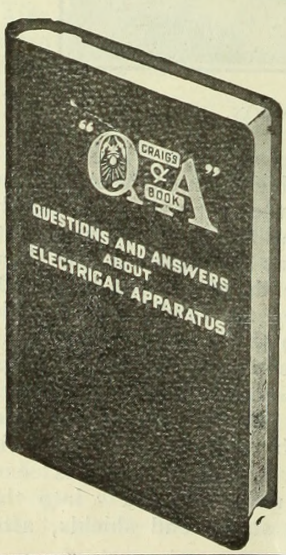
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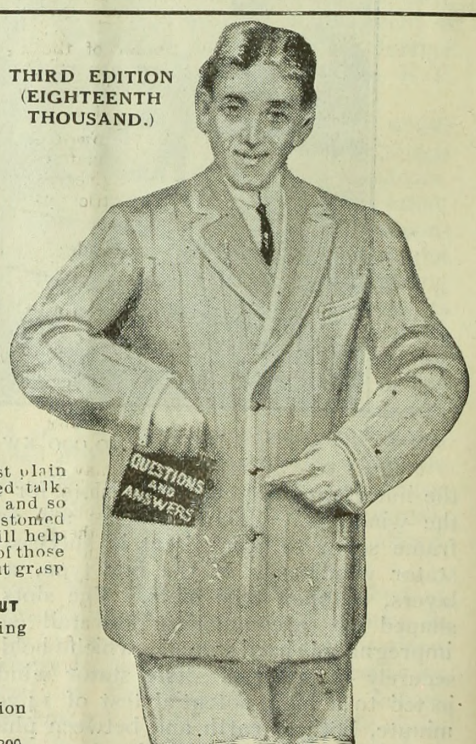
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cooling the end windings, also passes through the radial ducts in the stator core into the outer frame of the machine. From this point the air is carried, through a suitable flume, outside the building or into the boiler room.

(To be continued.)

SIEMENS' SPORTS.

The Siemens Sports Club held their first annual sports and gala on Saturday afternoon, the 23rd inst., at their sports ground, Park Lane, Charlton.

The ground was specially decorated for the occasion. Several additional tents and marquees were erected, and swings, roundabouts, cocoanut shies, etc., were provided for the more juvenile element, while the Eltham United Prize Band was also in attendance and added greatly to the festive nature of the proceedings.

The weather left nothing to be desired, and the programme of over fifty events was carried through with great enthusiasm and without the slightest hitch occurring.

It is estimated that there were some 7,000 or 8,000 people present.

The directors of the company were well represented by Lord Queenborough, General Sir H. de la Poer Gough, G.C.M.G., K.C.V.O., and Mr. W. O. Smith, and amongst the company present we noticed Messrs. G. H. Hume, M.P., L.C.C., Charles Pipkin, and F. Hird, the general manager of Siemens Brothers and Co., Ltd.

Various Items.

Tenders Accepted.—The tender of the Pirelli-General Cable Works, Ltd., Southampton, for the supply of additional low-tension cables and alterations to existing low-tension cables has been accepted by the L.C.C. Tramways Department.

Sweden.—The June issue of the *Swedish Economic Review* has reached us from the Swedish Consulate-General in London. It shows that at the present time engineering firms in Sweden are having a fair demand for electric motors and also for telephones.

Export Trade.—Reports of the trade, industry and finance of Finland, Sweden and Syria have just been issued by H.M. Stationery Office, and contain information of value to all who are interested in pushing the export trade of this country with those States.

Personal.—Mr. Roland Dunkerley, F.C.W.A., chief works accountant of the Metropolitan Vickers Electrical Co., Ltd., Old Trafford, Manchester, has been elected chairman of the Council of the Institute of Cost and Works Accountants, London, for the ensuing year.

Tenders Wanted.—Particulars may be obtained from the Dept. of Overseas Trade, Room 50, at 35, Old Queen Street, London, S.W.1, of the six water-tube boilers with electrically driven mechanical stokers and other accessories which are required for the White Bay power-house at Sydney.

A Trade Opportunity.—The Director-General of the Provveditorato Generale Ministero della Finanze at Rome has informed the British Commercial Secretary at Rome that he would be very pleased to receive from British firms catalogues of electric materials, including bulbs, lamp brackets, telephones and accessories.

An Engineering Dictionary Free.—We have much pleasure in once more directing the attention of our readers to the splendid offer which is being made by the Bennett College, Sheffield, of a wonderfully complete engineering dictionary which they are presenting free to readers under the headings listed in their advertisement in our pages. It is well worth writing for.

BRITISH STANDARD SPECIFICATION No. 168-1923, for the Electrical Performance of INDUSTRIAL MOTORS AND GENERATORS.

The British Engineering Standards Association has just issued a Specification—**British Standard Specification 168-1923,** for the electrical performance of Industrial Electric Motors and Generators—and we now have, for the first time in the history of the industry, an official British Standard Specification which provides for these machines a Rating in accordance with British practice.

OLD (Superseded)	NEW
BRITISH STANDARDISATION RULES No. 72 - 1917	BRITISH STANDARD SPECIFICATION No. 168-1923
50° C [90° F] Temperature Rise	40° C [72° F] Temperature Rise
Continuous Maximum Rating with NO MARGIN FOR SUSTAINED OVERLOAD	at Rated load with margin for SUSTAINED OVERLOADS of 25 p.c. for 2 HOURS for all continuous rated machines except the smallest and those totally enclosed.

The New British Standard Specification 168-1923 provides a **40 deg. Rating** for all machines (except those totally enclosed). This rating is the only one which has been in general use in Great Britain and the Colonies for the past twenty to twenty-five years; the issue of this Specification establishes the 40 deg. Rating as the official as well as the **actual British working standard.**

The "40 deg. Rating," has established itself and remained the working standard, in spite of competition from the "50 deg. Rating" as it provides a **margin for sustained overloads** (all machines, except the smallest and those totally enclosed, will carry without injury an overload of 25 per cent. for 2 hours), for running at full load on voltages differing from the rated voltage by as much as 10 per cent. and generally for standing up to abnormal conditions. It is the practical Rating, built on experience and thoroughly tried out in practice. The permissible temperature rise is 40 deg. C. as measured by the thermometer; measurement of temperature rise by increase of resistance of the windings is not provided for, so that anyone can ascertain, simply by applying a thermometer, whether the machine is in order and is not being overloaded.

The above notes apply only to **Continuous Ratings.**

N.B.—Short time ratings (half-hour and one hour ratings) are also provided for in the specification.

The Old British Standardisation Rules No. 72-1917 specified a "50 deg. C. Continuous maximum Rating," in which the machine was rated up to THE HIGHEST LOAD *it would stand with safety continuously,* AND NO MARGIN *was provided in the Rating for sustained overloads or for running at full load for extended periods when the voltage fell below normal. This Specification was never put into general use.*

The permissible temperature rise was 50 deg. C. when measured by thermometer, or 55 deg. C. when measured by increase of resistance of the windings.

The British Standardisation Rules No. 72-1917 are now withdrawn and no Industrial motor or generator with a continuous rating for 50 deg. C. temperature rise can any longer be called a British Standard Machine.

The price of this new official Specification is 1s. 2d. net post free, and it can be ordered from ELECTRICITY Office.

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Trade Notes.

Leaflet 595 II., which has just been issued by **Siemens Bros. and Co., Ltd.**, of Woolwich, describes the now well-known Siemens loud speaker for radio-telephony. It is suitable for use in the place of the ordinary double-head telephones in all cases where speech or music is received in sufficient volume. The material of which the horn is constructed is the result of exhaustive experiments, and gives the best possible acoustic results. The loud speaker is made in three types for resistances of 120, 2,000 and 4,000 ohms respectively.

The **Electric Heating Co.** have appointed Mr. M. J. Mills as their London representative in place of Messrs. Pinion and Willoughby, who will no longer have any connection whatever with the firm.

The Ella converter, for charging accumulators from D.C. circuits, has just been placed on the market by **Messrs. Lionel Robinson and Co.**, of 3, Staple Inn, London, W.C.1, and they have issued a neatly printed list giving an illustration of the machine and describing its method of operation. The list also includes details of their Ella wireless supplies, such as double-range voltmeters, head phones, crystals and sundries, so it should prove of value to all wireless readers, to whom it will be sent on application.

Booklet No. 989 has just been issued by **Simplex Conduits, Ltd.**, of Garrison Lane, Birmingham. It presents in a concise and eminently readable form a clear description of the various wiring systems supplied by the company, and the special purposes for which they are respectively suitable. It is hoped that by means of this catalogue many engineers who have only an indefinite knowledge of the performance of the various systems will become more fully acquainted with the main details and advantages claimed for each system. It should therefore appeal directly to every architect, consultant and contractor, to whom Simplex Conduits, Ltd., will be pleased to send copies on application.

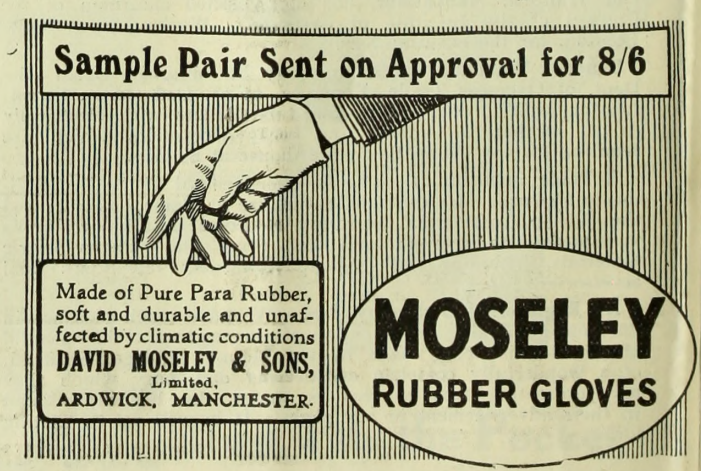
Messrs. Marconi's Wireless Telegraph Co., Ltd., issue a pamphlet descriptive of their Marconi telegraph-telephone station, Type "YC. 5." The Marconi "Y" series of self-contained sets are semi-portable, and are primarily intended for commercial or emergency telephony and telegraphy where direct wire communication is either impossible or at all events impracticable. They comprise a range of instruments of various powers for telephonic communication up to distances of about 200 miles. Each installation is provided in one of two forms—"stationary" or "mobile"—the principle differences consisting in the nature of the power supply and the method of connecting up the various units. Colonial conditions frequently preclude either the erection or economic maintenance of a direct line or cable between points desiring regular communication, and these latest Marconi productions afford a convenient and practical solution of such problems. The "YC. 5" set is of 500 watts capacity, and embodies a compact engine-generating unit for furnishing the necessary energy for transmission.

In "The Miracle of Radio," an artistic brochure published by the **Sterling Telephone and Electric Co., Ltd.**, that company's well-known broadcast receiving sets are associated with excellent photographic reproductions of some of the leading characters in grand opera, the illustrations being reproduced by exclusive permission of the British National Opera Co., Ltd. It will appeal to regular theatre-goers and music lovers, apart from its secondary function as a price list of the firm's broadcast receiving sets.

Gecophone wireless accessories are the subject-matter of Booklet B.C. 2984, issued by the **General Electric Co.**, a publication which will strongly appeal to the wireless experimenter desirous of constructing his own set. Like the complete wireless receiving sets bearing the same famous trade mark, "Gecophone" accessories are of the highest quality and workmanship, and in refreshing contrast with some of the cheap and nasty components now unfortunately finding their way on to the British market from foreign sources. Among the comprehensive selection of accessories listed, special attention may be directed to the "Gecophone" variometers, vario-couplers and variable condensers, both mounted and unmounted; loading coils and reactance coils for increasing the wavelength range of Gecophone sets; head phones, hand phones, head-phone distribution boxes for inter-connecting a number of head or hand phones, inter-valve and instrument transformers, valve-holders, and filament resistances. Coming down to greater detail, there is an ample selection of such primary parts as plugs, sockets and terminals, stud switches and parts, fixed condensers, grid leaks, crystal detectors and crystals, whilst a range of high-tension batteries, accumulators, and the more popular types of Marconi valve renders the catalogue a veritable *vade mecum* to the amateur constructor. Copies may be obtained from Magnet House, Kingsway, or any of the company's provincial branches.

Messrs. Metropolitan-Vickers Electrical Co., Ltd., have introduced their Cosmos radiophone "crystal set" amplifiers with a view to increasing the range of their already popular Cosmos crystal sets or alternatively enabling a loud speaker to be used with these sets within limited range of any broadcasting station. The Cosmos amplifiers are described and illustrated on Leaflet 640/2, and comprise both single and two-valve sets, either of which can be added to an existing Cosmos crystal set, and is designed to fit snugly into the space already provided in these sets. Another recent Cosmos radio product is the Cosmos radiophone protective device described in Leaflet 660/1 and designed for the protection of wireless installations against lightning or atmospheric discharges. The apparatus, which should be installed close to the point of entry of the aerial into the building, functions automatically, and it is claimed to render listening-in safe even during a thunderstorm.

The Aristophone Catalogue, 1923, issued by **Messrs. C. F. Elwell, Ltd.**, Craven House, Kingsway, London, W.C., is a high-class artistic production of some 55 pages. Fully illustrated with excellent half-tones, and every page relieved with tinted thumb-nail sketches, it represents a triumph of the catalogue publisher's art. The catalogue embodies particulars of an exceptionally wide range of complex receiving sets of all types and ranges for both short- and long-wage reception, as well as a selection of Aristophone panels for building up installations on the expanding bookcase principle. Each panel is a complete unit in itself, and similar panels are supplied for accommodating the batteries as well as for charging purposes, thus preserving uniformity throughout the series. In loud speakers there is a choice of four models, including the popular "Claritone" and the Aristophone cabinet model. In wireless furniture, three distinct period designs of cabinet are illustrated—viz., Cromwellian, Chippendale and Adam—all of which are extremely handsome specimens of the cabinet maker's art. The latter portion of the catalogue is devoted to radio-craft, under which title is classified apparatus and accessories enabling experimenters to construct their own sets. This section of the Aristophone list includes an exceptionally wide range of well-designed and appropriate accessories, the various illustrations being accompanied by concise descriptions and explanatory notes concerning the adaptability of the various components to set-building. A glossary of wireless terms and expressions completes a very excellent and serviceable publication, which, at the modest price of one shilling, should be in the hands of every wireless enthusiast. As a companion publication to their Aristophone catalogue, Messrs. Elwell also issue a shilling book of diagrams based on the use of Elwell rectifying and amplifying units and accessories. Each diagram is reproduced in triplicate, firstly a theoretical diagram, secondly a wiring diagram, showing the actual terminals on the units and how they are marked, and thirdly a wiring diagram showing the addition of filament regulators and jacks. The diagrams are in clear type, each part being individually marked, and with their aid and that of the Aristophone catalogue the experimenter should experience no difficulty in assembling the most complex installation.



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A POPULAR SCIENTIFIC WEEKLY JOURNAL
ELECTRICITY
A PRACTICAL TRADE JOURNAL

JULY 6, 1923.

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POWER FACTOR FROM THE CONSUMER'S POINT OF VIEW.

The evils of low power factor are now realised by every central station engineer, and vigorous efforts are being made to improve the power factor, particularly in undertakings where the only alternative is to install additional generators and larger cables to produce and distribute the "wattless current." To a great extent, low power factor can be avoided by simple action on the part of the consumer without the installation of "power factor correcting" apparatus. Prevention is indeed better than cure where low power factor is concerned.

In order to bring about a better state of affairs it is necessary first to make the consumer share the costs involved by low power factor, thus securing his interest in the matter of improvement, and then to educate him in the causes of low power factor, and the means of avoiding it. A recent article in the *Electrical World* provides a useful survey of the subject. The principal effects of low power factor, so far as the central station is concerned, are that increased generator capacity is required, excitation and line losses are increased, and a more expensive distribution system is required. In order to bring about an improvement, many central stations have increased the maximum demand charge in inverse proportion to the power factor for all power factors below 80 per cent. In some cases the maximum demand charge is reduced if the power factor exceeds 80 per cent., and in a few cases the energy rates (charge per kw. hour) are reduced if the consumer's power factor is high.

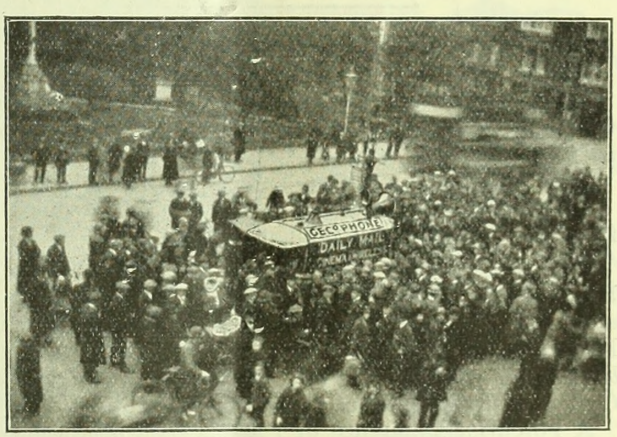
Points which should be brought to the notice of consumers are: (1) Induction motors of higher horse-power than is actually required run at less than full load and have then a low power factor. (2) Low-speed motors have a large number of poles, require heavier magnetising current, and therefore operate at lower power factor than high-speed motors. (3) From the point of view of power factor, group driving of machines by a single motor is generally preferable to individual driving, but the latter may reduce the true energy consumption. (4) A material improvement in power factor can often be effected by re-arranging or replacing motors, without the installation of any power factor correcting apparatus.

Synchronous motors can be built for very low speeds with good performance at a lower cost than induction motors of the same rating and speed, and can be operated at unity or leading power factor. The losses in a 200 h.p. synchronous motor, which is used instead of an induction motor and eliminates the 120 reactive kva. required by the latter, amount to 12 kw., but only 1 kw. is chargeable to power factor correction, the losses in the induction motor replaced being 11 kw. A phase advancer can be applied to a wound-rotor induction motor provided that the rotor of the latter is liberally designed. Static condensers cannot easily be adjusted to suit varying conditions of loads, and the cost of the condensers varies directly with the corrective kva. required, and is therefore high where large corrective effect is needed. The losses in the condensers are less than 0.5 per cent., and the overall loss, where transformers are required with the condensers, varies from 2.5 to 3 per cent. Synchronous condensers are not designed to transmit any mechanical load; their losses range from 11 per cent. in 100 kva. machines to 4 per cent. in 1,500 kva. units, and the cost per kva. decreases with the size of the machine.

Points which should be considered when selecting corrective equipment are:—The power losses in the corrective device; the interest and depreciation on the investment; and the increased operating expenses.

OPEN-AIR WIRELESS.

With the approach of the summer season the thoughts of wireless dealers naturally turn towards the use of wireless receiving sets outdoors, and there is no doubt that they have a wide sphere of utility at fêtes, garden parties, on the tennis court and on the river. No anxiety need be felt on the score of the suitability of wireless for outdoor demonstration, for the illustration we produce herewith of one of the four wireless



demonstration vans which have been equipped by the *Daily Mail* clearly indicates that excellent results can be obtained. The equipment consists of a "Gecophone" 2-valve set in conjunction with a "Gecophone" single-stage amplifier and a two-stage power amplifier. Each van has two loud speakers.

A novel feature of these equipments is the aerial used on three of the vans. This has been supplied by the

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General Electric Co., Ltd., and consists of a sectional bamboo mast 30 ft. high and a wire mesh aerial, the dimensions of which are 12 ft. by 4 ft. This type of aerial has been tested over distances of more than 100 miles from the London Broadcasting Station, and excellent results have been obtained, the concert being reproduced to large crowds in Birmingham, Shrewsbury and in the West of England.

Those who contemplate open-air demonstrations, therefore, during this summer may do so with every confidence that excellent results can be obtained, and that, too, with quite standard apparatus. The equipment described above is naturally extremely powerful, as the *Daily Mail* demonstrations are intended to appeal to large crowds. For entertaining smaller numbers, such as a char-a-banc or launch party, a proportionately smaller equipment would be required, and such can easily be built up from standard "Gecophone" apparatus. In this latter connection we are able to reproduce by courtesy of Messrs. Wireless Service, Ltd., a photograph of a punt which this company, in association with Electrical Installations, Ltd., have equipped for wireless demonstrations on the Thames.



At the extreme end of each punt arises a slender bamboo pole carrying the aerial, to which is coupled a 2-valve "Gecophone" wireless receiving set, together with a large loud speaker equipment. Some highly successful trips have been made in this punt, which has been able to prove in no uncertain fashion the practicability of river wireless.

TELEGRAPHY.—GRADE I. (1923).*

Being Solutions to the Questions set by the City and Guilds of London Institute in the Grade I. Examination in Telegraphy held in May, 1923.

Q. 1.—Define the terms volt, ohm, ampere, coulomb, farad, microfarad, and milliampere.

A. 1.—*Volt.*—The volt is the practical unit of Electromotive Force, or Potential Difference, and is equal to 10^8 absolute electromagnetic units of Potential Difference. *It is equal to .6974 of the electrical pressure between the poles of a voltaic cell, known as the Clark's Cell, at a temperature of* 15 *deg. Centigrade.*

A Potential Difference of 1 volt exists between two points on a conductor when 10^7 ergs of work are done in moving 1 coulomb of electricity from one point to the other along the conductor.

Ohm.—The ohm is the practical unit of Resistance, and is equal to 10^9 absolute electromagnetic units of resistance. It is defined as "*The electrical resistance offered to an unvarying current by a column of mercury* 106.3 *centimetres long,* 14.4521 *grammes in mass, of a constant cross sectional area, at the temperature of melting ice.*"

Ampere.—The ampere is the practical unit of Current, and is equal to 1/10th of the absolute electromagnetic unit of current. It is defined as "*That unvarying electric current which, when passed through a solution of silver nitrate, of particular strength, deposits silver at the rate of .001118 grammes per second.*"

Coulomb.—The coulomb is the practical unit of Quantity, and is equal to 1/10th of the absolute electromagnetic unit of quantity. *It is the quantity of electricity conveyed by an unvarying current of* 1 *ampere in* 1 *second.*

Farad.—The farad is the practical unit of Capacity, and is equal to 10^{-9} absolute electromagnetic units of capacity. *It is the capacity of a conductor, such that* 1 *coulomb of electricity will raise its potential by* 1 *volt.*

Microfarad.—1 microfarad is equal to one-millionth of a farad. It is the unit of capacity generally used in practical work as the farad is too large for ordinary purposes.

Milliampere.—1 milliampere is equal to one-thousandth of an ampere. In telegraphy working currents are generally very small, and as a matter of convenience are usually expressed in milliamperes.

(*To be continued.*)

* *The standard text books for this Grade are: "The Telegraphist's Guide," by Bell & Wilson (20th thousand, 3s. 6d. net), and "Questions and Solutions in Telegraphy and Telephony, Grade I." by Few (5th edition, revised, 5s. 6d. net).*

BROADCASTING OPERAS IN THE UNITED STATES.

In broadcasting grand opera, the microphones which are to pick up the sound vibration are carefully located in the proper places. A knowledge of the stage acoustics and of the opera is very necessary. The microphones, three in number, must be so located as to pick up every sound made, either by the orchestra, soloists or choruses. They must be judiciously placed so that the sound will not be too strong, or too weak, as the actors move about.

One of the microphones is placed under the stage, in front of the prompter's box, and facing the orchestra and audience, in the orchestra pit. This instrument will serve to pick up the orchestral music. Two microphones are placed to the right and left of the prompter's box. Occasionally the microphones are moved to the wings, or to some other place more advantageous acoustically. Sometimes special "pick-up" horns are fitted to the microphones in the case of solos or subdued singing. These microphones are connected to a small control-switch box, and by means of switches, either microphone, or all of them, may be connected in circuit. This permits the control of any one of the microphones and the picking up of sounds on any part of the stage as the opera progresses and requires.

From the control box, the impulses picked up on the stage are sent through a speech amplifier, which is usually located under the stage. In the cabinet are placed the usual transformers, tubes and repeater tubes necessary for amplifying the weak impulses before their journey to the broadcasting station. Energy for the speech amplifier and microphones is supplied by a unit of four 6-volt storage batteries, from which connections

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are made to the various controls. The output from the speech amplifier is fed into the Western Union wires, which connect directly with the station. In its journey from the theatre to the station, the electrical impulses go through underground conduit, pole, and under-water ducts and pipes, then again via poles to the Westinghouse Electric plant in Newark, N.J.

On top of the manufacturing building, which is situated not far from the Lackawanna Railroad station, are located the operating and transmitting rooms, and the aerial and counterpoise systems. It is to the control switchboard in the transmitting room that the impulses from the theatre come. Here they are amplified again, because they are weakened in their underground, submarine and air trip before they reached their first stop on their lengthy journey. By means of the station voice amplifier and of the intermediate modulator tube, the original electrical impulses picked up on the stage of the opera house are magnified so that they can now be supplied to the five powerful modulator tubes, of 250 watt rating each. This energy, which is perfectly modulated, goes to the oscillator tubes. These four tubes supply 1,000 watts of energy directly into the radiating system. A pick-up coil located near the transmitter switchboard permits a check on the modulation. Direct communication by telephone with the announcer in the theatre is useful for an exchange of information on adjustments on both ends which will result in perfect broadcasting on the subject. From the huge antenna and counterpoise system the radio waves radiate for thousands of miles in all directions, to be picked up by listeners-in in every land.

The experiment of broadcasting opera music was interesting technically and from a musical standpoint. It was long a doubtful thing as to whether it was possible to transmit operas by radio. Because of the various effects, both climatic and of delicate tone colouring, the problem, from a technical standpoint, was a difficult one. However, the radio engineer has succeeding in solving the problem, and the musician agrees that he solved it well.—*Telegraph and Telephone Age.*

G.E.C. "FREEZOR" FAN CAMPAIGN 1923.

We have received from the General Electric Co., Ltd., Magnet House, Kingsway, W.C.2, a selection of new fan literature for the 1923 "Freezor" fan campaign, comprising a complete catalogue section, folder and show cards.

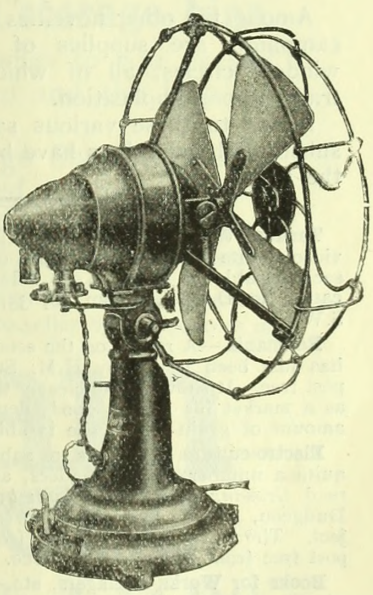
The catalogue section V3 is now enlarged to 44 pages, and, in addition to a fully illustrated description, with prices of all types of "Freezor" fans, contains two new features: (1) a 12-page introduction which gives a very full technical description, with splendid sectional illustrations, of all the principal types of "Freezor" fans; and (2) a complete catalogue of spare parts of standard fans, each part being numbered to correspond with the series of sectional drawings, which are also reproduced.

The list now shows particulars of desk and bracket fans, of rigid, adjustable and oscillating types, ships' and railway fans, coiling fans, exhaust fans and speed regulators.

The folder V3013, which we reproduce, is a new three-colour design, which is also repeated in the new showcard and poster, both of which are now available.



"FREEZOR" FAN WORKS—ASSEMBLY BENCHES.



"FREEZOR" OSCILLATING FAN, AS DESK FAN. (12-IN. BLADES.)

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We understand that supplies of the folder are available for overprinting with dealers' names and addresses, and that invitations for the requisitioning of supplies of these have been issued to the trade.



DESIGN FOR FOLDER, POSTER AND SHOW CARD.

Among the other novelties provided for this season's campaign are supplies of novelty parachutes and window circles, all of which will be distributed to traders upon application.

Added to these various sales aids is the fact that substantial reductions have been made in the prices of the fans.

Tenders Wanted.—The State Electric Light Works at Montevideo invite tenders for eight overhead electric transporters, each capable of lifting 3,000 kilograms. Particulars on application to D.O.T., Room 50, 35, Old Queen Street, London, S.W.1.

Roumania.—A report on the economic conditions in Roumania has just been issued by H.M. Stationery Office, price 2s. 2d. post free. It shows quite clearly that the prospects of Roumania as a market for British goods depend almost entirely upon the amount of grain which she is able to export each year.

Electro-culture.—This is a subject which should interest quite a number of our readers, and we should advise them to read *Growing Crops and Plants by Electricity*, by Miss E. C. Dudgeon, who is one of the foremost authorities on this subject. The price is 1s. 6d. net from any bookseller, or 1s. 8d. post free from ELECTRICITY office.

Books for Works Managers, etc.—Bound copies of Volume II. of *The Cost Accountant*, the official journal of the Institute of Cost and Works Accountants, Ltd., containing numerous articles on costing and works accounting in various industries, are now available. Price to non-members, 30s. post free; members, 25s. post free. Obtainable from the office of *The Cost Accountant*, 38, Grosvenor Gardens, S.W.1.

Questions and Answers by Practical Men.

RULES.

QUESTIONS: *We invite our readers to send us questions, preferably on technical problems that have arisen in actual practice. Questions which we consider of sufficient interest to our readers will either be replied to under "Answers to Correspondents" or replies will be invited from our readers. One shilling will be paid for the question which we select for competitive replies in this column.*

ANSWERS: *A fee of 10s. will be paid for the answer which we consider shows the greatest merit, and 5s. for the one we select as second best. In judging the replies, importance will be attached to clearness and conciseness, as well as accuracy. The Editor reserves the right to make no award, or to accept only one reply, if, in his opinion, the answers received do not possess sufficient merit. Competitors desiring the return of their manuscripts, if unaccepted, should enclose stamped addressed envelope.*

Write on one side of the paper only, and if diagrams are sent, draw them on a separate sheet of paper attached to the manuscript. Competitors may adopt a "nom de plume," but, both in the case of questions and answers, the competitor's real name and address must be sent with the manuscript as a guarantee of good faith. No correspondence will be entered into with regard to successful replies. The Editor's decision is final.

Commencing with Question No. 101, a Diploma of Merit will be awarded to the six competitors who win the first or second prize the most times during the next twelve months.

The words "Questions and Answers" or "Q" and "A" should be placed a the top left-hand corner of all letters intended for this column.

QUESTION NO. 163.

I have a room 32 ft. long and 18 ft. wide. I wish to light it with electric light. I wish to produce about 6-foot candles intensity at the working plane, about 4 ft. from the ground. I would appreciate details of how many points to fit and the candle-power of the lamps.—"CUTTER."

QUESTION NO. 164.

I have an electric iron, but it has gone wrong. I have opened it out, and I find that the element is what appears to be aluminium paint on mica. I also notice that the circuit through this paint is interrupted. Since I cannot purchase a spare element, is there any means of repairing the defective element? If not, how can I convert the iron to use another element?—"LAUNDER."

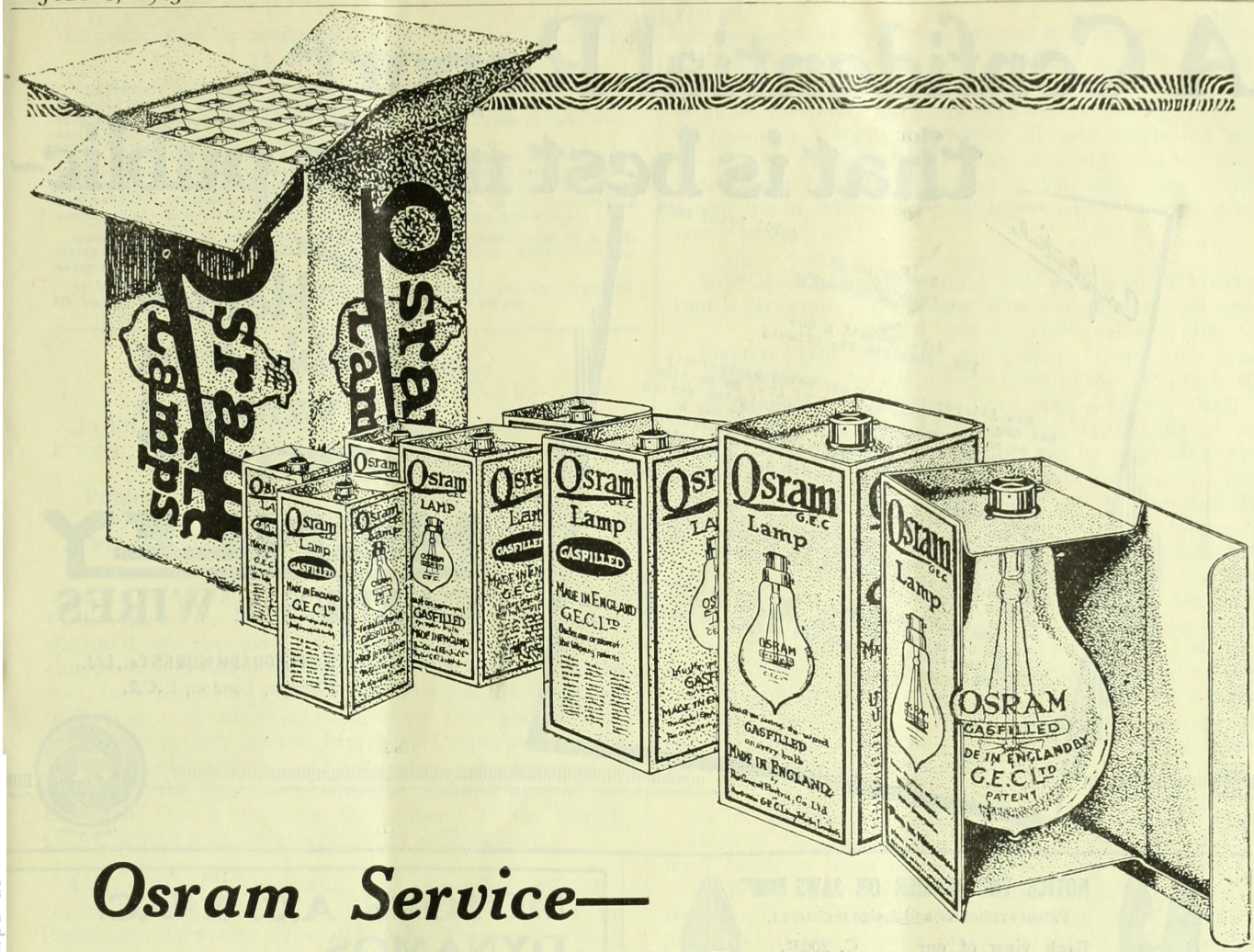
(Replies to Questions Nos. 163 and 164 must be received not later than July 28, 1923.)

M.P.s AND RADIO.

On Wednesday, June 27, members of the Industrial Group of the House of Commons paid a visit to Radio House, and to the wireless transmitting and receiving stations situated at Ongar and Brentwood respectively. In connection with this visit we have received from Messrs. Marconi's Wireless Telegraph Co., Ltd., a souvenir booklet, which was printed in commemoration thereof. Unlike many so-called souvenirs, this booklet is something which is well worth keeping, and, we would add, well worth producing. In these days of bad colour processes, its simplicity is distinctive. The pictures and portraits are more like Bromide prints than printed reproductions. The text describes briefly the method of control and how the high-speed services dealt with at these and other stations are handled from Radio House, the nerve centre of the Marconi high-speed commercial services.

It is visits such as this that must help to broaden the outlook of our Parliamentary representatives, and open their eyes to the possibility of extending our national commercial interests. Wireless telegraphy, being the most up-to-date means of communication, must be in the forefront of our future advancement, and there is no doubt that the extension of high-speed wireless services is a matter of vital importance.

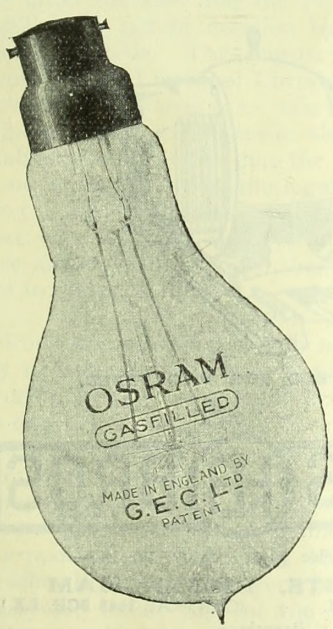
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Osram Service—

A TALK WITH THE RE-SELLER.

No. 8 - A method of Packing which does away with storage bins.



Every OSRAM Gasfilled Lamp comes to you packed in a separate carton in which the cap and the 'pip' of the lamp are both secured.

The Cartons are then packed in large fibre-board containers, which can be readily stacked. Bins are then quite unnecessary. This method of packing renders breakage practically impossible and storing easy and safe.

This is another example of the practical help given to the Re-seller by the makers of

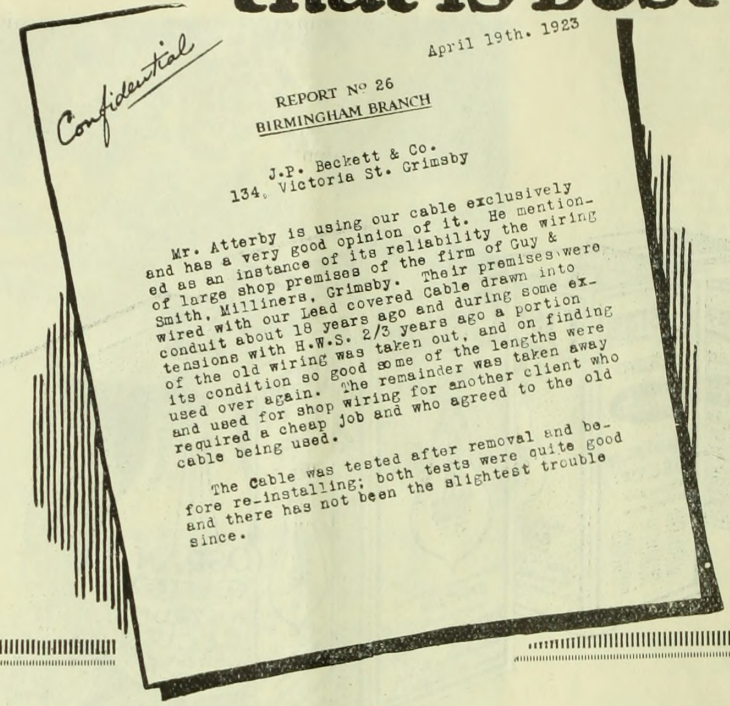
Osram G.E.C.

GASFILLED LAMPS

Advt. of The General Electric Co., Ltd., Magnet House, Kingsway, W.C.2.

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A Confidential Report that is best made public-


Confidential

April 19th. 1923

REPORT No 26
BIRMINGHAM BRANCH

J.P. Beckett & Co.
134, Victoria St. Grimsby

Mr. Atterby is using our cable exclusively and has a very good opinion of it. He mentioned as an instance of its reliability the wiring of large shop premises of the firm of Guy & Smith, Milliners, Grimsby. Their premises were wired with our Lead covered Cable drawn into conduit about 18 years ago and during some extensions with H.W.S. 2/3 years ago a portion of the old wiring was taken out, and on finding its condition so good some of the lengths were used over again. The remainder was taken away and used for shop wiring for another client who required a cheap job and who agreed to the old cable being used.

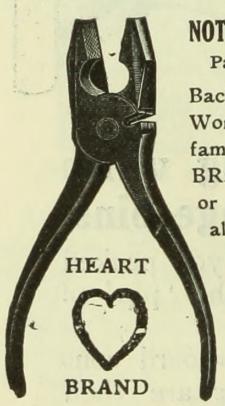
The Cable was tested after removal and before re-installing; both tests were quite good and there has not been the slightest trouble since.

A another Henley Cable that is working overtime

HENLEY
CABLES & WIRES

W. T. HENLEY'S TELEGRAPH WORKS Co., Ltd.,
Blomfield Street, London, E.C.2.

TRADE MARK

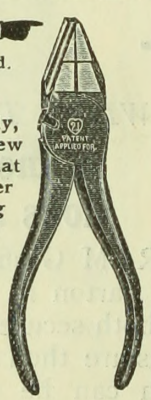


NOTICE THE REAMER ON JAWS

Patent applied for and design registered.

Back view of our World-known and famous "HEART BRAND" Cutting or Bell Pliers in all sizes, 4 in. to 7 in. rising by ½ in., and 8 in., 9 in. and 10 in. sizes.

C. 200R. 6 in. size only, something new in Pliers, that is a reamer for removing burrs inside of conduit tubing without the use of extra tools



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Oakey's "Flexible Twilled" Emery Cloth.

For Engineers, Sewing Machine, Lock and Scale Makers, and all purposes where great STRENGTH, DURABILITY and PERFECT FLEXIBILITY are required.

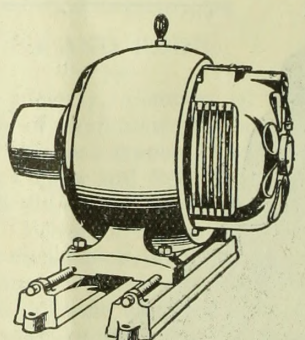
FLINT & GARNET PAPER IN ROLLS.

50 yards long by 18 in., 20 in., 24 in., 30 in., 36 in., 40 in., 42 in., & 43 in. wide.

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WELLINGTON EMERY AND BLACK LEAD MILLS, LONDON, S.E. 1
ALL BRITISH MADE.

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TO OUR READERS.

ELECTRICITY is published every Friday, and, if ordered, is on sale at the principal Railway Station Bookstalls and Newsagents on that day. It has a very large sale throughout the United Kingdom, as well as in the British Colonies and Abroad.

New advertisements for the displayed columns and alterations to existing ones must reach the publishing office not later than first post Tuesday morning, in order to be in time for the issue of the following Friday. This is important. Rate quoted on application. Subscription: 13s. a year, 6s. 6d. half year, 3s. 3d. a quarter in advance, postage prepaid in the United Kingdom and abroad.

Questions to which an answer is required must be accompanied by a 1½d. stamp for reply. When considered of sufficient interest, the answer will probably appear in the paper.

All remittances payable to the Publishers, S. RENTELL AND CO., LTD., 36-39, Maiden Lane, London, W.C.2. Telephone No. 2460 Gerrard.

Current Topics.

Public Pay for Costly "Principle."

In these times of financial stringency, when the call is ever for economy in expenditure of public funds, it certainly calls for drastic comment that two public bodies or their official representatives as servants of the taxpayer should be empowered to go to law over a very trivial matter, and, what is more, carry the dispute right through various Courts up to the House of Lords, where it was finally disposed of, the presiding judge making some very caustic observations on the case which were, nevertheless, fully justified. The case arose in the first place out of damage to a telephone cable in the Liverpool district, caused by a fault on the Liverpool Corporation's electricity supply mains. The damage was assessed at £40, and the Postmaster-General claimed against the Liverpool Corporation for this amount in the County Court, where a decision was given against him.

A Divisional Court was next appealed to for a reversal of this ruling, and found in favour of the Postmaster-General. The defendant Corporation then took its case to the Appeal Court, where the original County Court ruling was upheld, and it was against this latter decision that the Postmaster-General sought a still more potent decision by taking the case to the House of Lords. That august body, however, found in favour of the Liverpool Corporation, and Lord Carson took the opportunity to administer a rebuke to the litigants and to characterise the case as an attempt to establish the principle that the Postmaster-General can do no wrong. About the legal aspects of the controversy I have nothing to say. Law is ever costly, and those who want plenty of it and can afford to pay the price are entitled to spend their all on litigation if they care to do so.

When it comes to spending my money, however, and that of other unfortunate taxpayers and ratepayers in securing pettyfogging legal decisions on subjects like the one under criticism, I for one strongly object. It does not matter a brass farthing to me whether the Liverpool Corporation or the Postmaster-General were responsible in point of law for the £40, which was the amount of the original damage. In the one case Liverpool ratepayers would have to foot the bill, in the other Liverpool taxpayers, in conjunction with other taxpayers, would pay for the damage, and there the matter would end. As the case stands now, both Liverpool ratepayers and taxpayers and, in fact, all taxpayers will have to pay a total amounting to several thousands of pounds for having afforded certain interested officials the opportunity of airing their opinions in Courts of Law and the House of Lords. In my opinion, the public servants who authorised legal action in connection with this paltry dispute ought to lose their jobs now—and renounce any rights they may individually have to a pension. Why are these people never made an example of when cases of this kind come to light?

Electric Light and Miners' Nystagmus.

Ever since a certain medical man advanced the theory that nystagmus (a nervous affection of the eye prevalent among colliers) was due to certain emanations from the coal itself, the sponsors of the older form of illuminant have been decrying electric lamps for miners as calculated to enhance the dangers of coal mining by depriving the collier of his old-fashioned test for fire damp, viz., the character of the flame of the Davy safety lamp and its derivatives. They argue that since, according to recent authority, nystagmus is not attributable to deficient illumination, there can be no logical reason for the substitution of electric for oil lamps, even on the plea of greatly improved illumination at the working face. From the speciously worded advertisements of the makers of miners' oil lamps in the journals devoted to the mining industry, one would infer that the miner's electric lamp was about the most dangerous invention of the age, and that adherence to the Davy principle was the sole chance left to the collier of to-day of surviving.

In the circumstances, and recognising that the supporters of the more modern system of lighting have a hard battle in front of them before they can claim to have firmly established their product to the general benefit of coal miners, it is refreshing to give equal publicity to the records of important collieries which *have* adopted the miner's electric lamp and proved its worth by having experience and carefully kept records. Thus, at the opening of a large institute and recreation ground provided by the Butterley Colliery Company, under the Miners' Welfare Scheme, presided over by Viscount Chelmsford, Mr. G. Spencer, M.P., speaking on nystagmus, announced that since the Butterley Company had introduced electric lamps into the pit these cases had been reduced 60 per cent., whilst another colliery company in the district also stated that their claims for nystagmus compensation were less by 40 per cent. since the introduction of electric lamps into the pit. An ounce of practice is worth tons of theory, and it is high time the Home Office intervened and settled this vexed question to the satisfaction of all parties. There must be plenty of evidence available to prove the unquestionable advantages of electric lighting over oil lamps for an industry carried on in such dingy surroundings.

The Electrical Contractors' Association.

The chairman's announcements at the annual general meeting of the three bodies representing the electrical trade again showed that the principal electrical contractors throughout the country are doing good work in organising their industry and erecting safeguards against shoddy workmanship, price cutting, and the machinations of the unskilled dabbler with pliers and soldering iron. Following on their recent strong declaration of a general policy which,

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if carried out to its fullest extent, would place the electrical trade on a very firm basis indeed, the most important announcement at the general meeting was probably that concerning the scheme for the voluntary registration of electrical contractors, instituted by a committee set up by the Institution of Electrical Engineers.

According to the chairman (Mr. Marryat) this scheme has already received every possible support. The registration authority has been constituted, and no less popular a personage in the electrical world than Mr. C. H. Wordingham has accepted the chairmanship, a fact which is in itself a guarantee of further enthusiastic support. The Electrical Contractors' Association is adequately represented upon the registration authority, and formalities are now being pushed forward with a view to the scheme being launched at an early date. In collaboration with this scheme of voluntary registration of electrical contractors there is being developed and popularised a standard E.C.A. sign, which, it is hoped, will eventually become the seal or mark of high-class workmanship, and tend ultimately to freeze out all those irresponsible and inexperienced firms and individuals who have been exploiting the electrical contracting trade to its detriment.

Another phase of its activities upon which the Association deserves commendation is in its activities in relation to labour, with which its members claim to be on the most friendly footing. According to the chairman, the Whitley system of Joint Industrial Councils and National Joint Industrial Councils has proved effective in making clear to each side the other's difficulties, and has created on both sides an appreciation and respect for the other's straight dealing. This reputation the council of the Association does its best to foster. The national sliding scale agreement has worked well, and although in certain isolated cases members have suffered by the operation of the agreement, they have appreciated that its maintenance is of the utmost importance, and have acted loyally by the Association. Undoubtedly the contractor's organisation is a very live body, and is doing its full share towards raising the status of the industry in which it plays such an important part.

The I.E.E. Conversazione.

The President and Mrs. Gill entertained their numerous guests at the annual conversazione on the 28th ult. at the Natural History Museum, and I congratulate them most cordially on the very happy evening which everyone seems to have spent. It was a pleasure to notice many old and familiar faces, and, although space does not permit me to give the full list of all the notabilities who were present, I can, I am certain, say that we were all delighted to see such veterans as Colonel Crompton and Sir Henry Mance apparently quite at home with their old friends. Dr. Ferranti, Mr. Mordey, Mr. Atkinson, Mr. Rawlings, and, indeed, a host of senior members, added their cheerful presence to the enjoyment of the evening, and the musical entertainment was, as usual, of the very highest order.

It was, however, curious to hear the different opinions expressed in regard to the condition of the electrical industry. Some old friends were very pessimistic, and others, in fact, the majority, spoke in quite a cheery vein, and seemed to think that business altogether was looking very much brighter. Let us hope that by the time the next conversazione comes round we shall all be feeling the benefit of the trade improvement, which, I am confident, is proceeding on such sound and progressive lines.

ELEKTRON.

THE G.E.C. FOURTH ANNUAL SPORTS.

We had pleasure in accepting an invitation of the General Electric Company's Sports Committee to attend the fourth annual meeting held at Herne Hill on Saturday afternoon, June 23. We always like to attend functions of this description, not only because they tend to blow the cobwebs—which somehow have a knack of forming towards the end of a hard week's toil—away, but because it gives one an opportunity of knocking some of those rough corners off which form

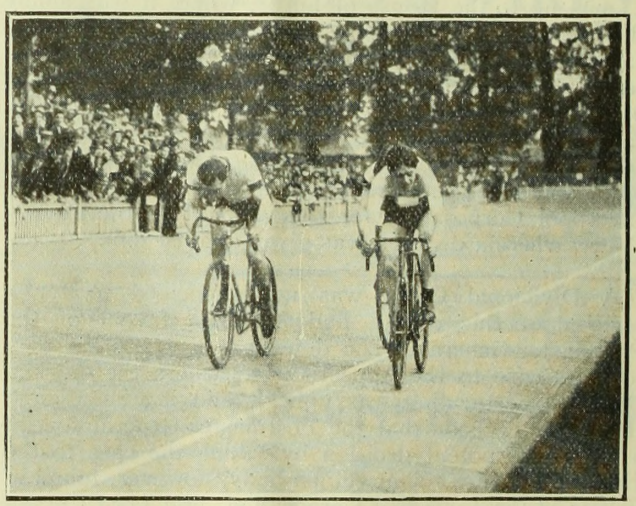


FIG 1. THE DEAD HEAT IN THE ONE MILE CYCLE RACE

on ones disposition from time to time. There are not sufficient of these functions, and we would like to see more of them. There is nothing finer in the world than clean healthy sport. It makes life worth living, since the friendly antagonism of the sports ground is reflected in the shape of a better feeling and understanding in the office and workshop.

We were not surprised, in a chat with some of the committee, to find that our views were expressed by them. In fact, Mr. Carter, under whose wing we were placed, told us that they realised the necessity for greater social co-operation, and they were going to leave no stone unturned to obtain it. Their social committee were considering a social campaign, so to speak, the object being to make their staff and employees real friends. This object is good since everyone knows that friendship in business is productive in good results.

We were surprised, in a way, at the manner in which the committee and other officials handled the arrangements at their sports. Everything seemed to work so

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smoothly. In this direction great assistance was rendered by Mr. Campbell with the megaphone. He seemed to find the correct *wavelength* every time. He *tuned* the competitors up in such a manner that, at one period of the afternoon, he actually beat the clock. This he *broadcasted*, and rightly too. It is not everyone who can do the half-hour in five and twenty minutes.

Referring to the sports, it must be said that each event was well contested. The *power factor* of the competitors, generally speaking, was very high. In the mile race one competitor had a very large start, but he could not maintain it. From the stands we could see his *voltage* gradually falling until his *reverse current relay* tripped, and he fell out when opposite the stands. It was not surprising considering the extremely hot day.

The ladies' tug-of-war was one of the best-contested events of the day. The best side won, but we could not help feeling sorry for one young lady of the typewriting team. She assisted materially to help her side win the preliminaries, and she was a real trier in the final pull.

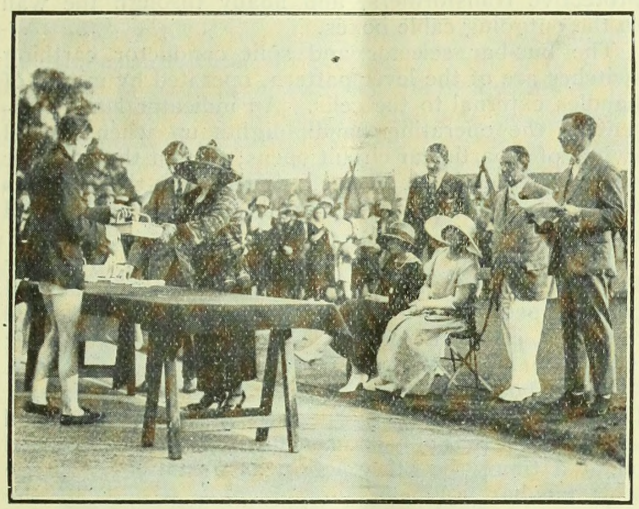


FIG 2. MRS. HIRST DISTRIBUTING THE PRIZES.

But she could not help the *insulation* of the rest of the team giving out which brought them to *earth*. We repeat, we were sorry.

The three-legged race was very well contested. Some of the young ladies must have had a great deal of practice to be so perfect in such difficult running. One heat was very humorous. Two gentlemen (who shall be nameless) ran in this heat. From what we could see from the stands a *phase advancer* or an *induction regulator* was greatly needed since the power factor appeared to be *lagging* very much.

The mile cycle race was keenly contested, and resulted in a dead-heat between E. B. Brodie and E. J. Tatlock. They decided to ride this off, and it resulted in a win for the former. In the decider it was a very close thing, E. B. Brodie winning by about half a wheel.

In H. J. Barron the G.E.C. have an excellent runner. His time 53 3-5 secs. for the 440 yards scratch is very good indeed. He also won the 220 yards flat, very easily we thought.

The high jump produced an excellent jumper in W. E. G. Rutherford. He was not put to a great deal of exertion to win. In an exhibition jump, later, he cleared 5 ft. 3 in. without an effort. It would have been interesting to know exactly what he could have done, and we think the committee should have tried him with more than 5 ft. 3 in. Athletes of his kind are very scarce. He also won the long jump with 19 ft. 11 in., a very good performance.

Other items resulted as follows:—100 Yards Flat Handicap (junior males): 1, J. G. Jago; 2, G. S. Wheeler; 3, W. E. Kennish. 100 Yards Flat Handicap (senior males): 1, A. S. Robinson; 2, W. J. Wright; 3, H. J. Barron. 100 Yards Veterans: 1, G. L. Waterman; 2, M. Campbell; 3, G. Acton. 75 Yards Flat Handicap (junior ladies): 1, E. White; 2, E. N. Majoram; 3, E. Varcoe. 75 Yards Flat Handicap (senior ladies): 1, C. S. Meekings; 2, E. M. Page; 3, D. Ansell. 100 Yards Flat Scratch: 1, A. S. Robinson; 2 W. C. Grant; 3, H. H. Monnery. 220 Yards Flat Handicap (junior): 1, C. J. Jago; 2, E. H. Bowthorpe; 3, J. W. Scott. 220 Yards Flat Handicap (seniors): 1, H. J. Barron; 2, W. J. Wright; 3, J. E. Rigby. Tug-of-War (males): Fraser and Chalmers beat Express Lift. 220 Yards Flat Scratch: 1, S. W. Westbrook; 2, A. S. Robinson; 3, H. Stonehart. One Mile Cycle Handicap: 1, E. B. Brodie; 2, E. J. Tatlock; 3, H. E. Carpenter. High Jump: 1, W. E. G. Rutherford; 2, J. Bland. Tug-of-War (ladies): Osram A beat Typewriting. One Mile Flat Handicap: 1, A. Gibbs; 2, H. A. Mackay; 3, W. Gwilliam. ¾-Mile Relay Race (males): W. E. G. Rutherford, M. A. Hall, G. J. Jago, W. C. Grant. 60 Yards Sack Race: 1, D. F. Carter; 2, L. Du Cane; 3, F. Payne. 75 Yards Scratch, Osram Ladies (seniors): 1, C. V. S. Santon; 2, C. M. Meekings. (Juniors): 1, E. White; 2, D. F. Farquhar. Long Jump: 1, W. E. G. Rutherford; 2, K. W. Smith; 3, A. W. Knight. 440 Yards Scratch: 1, H. J. Barron; 2, F. H. Moorman. 60 Yards Boot Race: 1, J. V. Sanders; 2, L. J. Jarvis; 3, A. M. Milton. 375 Yards Relay Race (ladies): D. Wilkinson, G. Scarlett, K. Varcoe, F. Rust, G. Cannon. 880 Yards Flat Scratch: 1, A. Gibbs; 2, H. Stonehart; 3, W. R. Wood.

Answers to Correspondents.

DRAUGHTSMAN.—Better write to W. F. Stanley and Co., Ltd., and ask for a copy of their drawing instrument catalogue, L7. We expect it will give the details you require.—*Editor*, ELECTRICITY.

New South Wales.—During March electrical goods value £612 were imported from Germany.

Miners' Safety Lamps.—The following types—viz., Laidler lamp, Type L.C. No. 1; Cambrian lamp No. 30; "Thor" pillarless electric hand lamp, S.P. type; "Oldham" pillarless electric hand lamp; Wolf nickel cadmium inspection lamp No. 608; "Ceag" deputy lamp; and Oldham No. 3 hooded lamp (for officials)—have been approved for use in all mines to which the Coal Mines Act, 1911, applies.

Finance.—The report of Crompton and Co., Ltd., for the year ending March 31, 1923, shows a loss on the year's working of £7,185 after payment of debenture interest, etc. The outlook is, however, very much brighter.——It is pleasing to note that the shareholders of the Edison and Swan Electric Co. have agreed to the suggested reorganisation of the finances, and that once this has been arranged there is every prospect of a satisfactory profit being earned in the near future.

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THE ROTHERHAM POWER STATION.

(*Concluded from page* 349)

This system of radial air ducts in the magnetic structure of both rotor and stator makes possible a very efficient use of the ventilating air, and ensures uniform cooling. The intake air is drawn through an air washing plant, which removes dust particles which would otherwise, in course of time, accumulate in the air passages of the machine and reduce the efficiency of the cooling.

The exciter, which is mounted on an extension of the main bedplate is a 4-pole, shunt-wound, self-exciting machine with commutating poles, and is connected direct to the alternator rotor windings, without a series rheostat, the control being effected by a rheostat in the shunt field circuit. The armature is direct coupled to the alternator shaft through a flexible coupling and equipped with an outboard pedestal bearing. The armature is of the slotted drum type, the winding consisting of copper bars insulated with mica. The bearings of the alternator and exciter are lubricated under pressure from the main turbine oil supply system, and efficient means are provided for preventing oil escaping along the shafts from the bearings and finding its way into the machines.

The alternator is designed with high internal reactance, so that in the case of accidental short circuit occurring at the terminals of the machine, the maximum momentary current is limited to a safe value, thus protecting the set against injury. On this account external protecting reactors in the generator circuit are unnecessary.

SHORT-CIRCUIT TEST.

An interesting test, subjecting the turbo-alternator to a sudden single-phase (line to line) short-circuit, when running excited at full voltage, was made at the Rotherham Corporation Electricity Works before finally passing the machine for service. In order to carry out the test, the section of the bus-bars to which the machine is normally connected was isolated from the rest of the system on the far side of the bus-bar interconnecting switch, and two of the three terminals of this switch were short-circuited on the far side by heavy copper connectors.

The actual short-circuiting of the machine was performed by closing the bus-bar interconnecting switch, the main switch having been previously closed and set to trip instantly on overload, thus making the conditions much more severe than when the time-lag device is used. In this manner a test was obtained, not only on the alternator, but also on the B.T.-H. motor-operated oil switch which was used.

It is interesting to note that the switch opened the fault in an extremely satisfactory manner, the only visible result being the throwing of a small quantity of oil, estimated at about half a pint, the cleaning up and replacement of which is a very small price to pay for clearing a fault on the bus-bars of a large power station. On a similar switch, used to make the short-circuit, no oil was thrown and no parts were in any way damaged, despite the very severe conditions of closing on a dead short-circuit.

In view of the size of the unit under test, the forces are necessarily large, and it is very satisfactory to find that the whole of the installation, including turbine, alternator, cables and switchgear, withstood the test without any signs of distress.

THE SWITCHGEAR.

The H.T. switchgear is housed in an annexe to the generating station and occupies three floors, the L.T. control panels being installed in a separate room at one end of the annexe. The first floor of the annexe contains the oil-break switches; the ground floor contains the bus-bars, isolating switches, and instrument transformers; while the basement is reserved for bus-bar reactances with their attendant switchgear, and for the generator neutral point earthing resistances and their isolating switch pedestals. The whole of the H.T. switchgear is of the cellular type with phase barriers, so that any fault which may occur on the switchgear will be confined to the particular phase and piece of apparatus concerned. Duplicate bus-bars are provided, one set being located on each side of the 9 in. concrete wall, three of which run the whole length of the ground floor dividing it into four compartments.

The bus-bar selector switches are mounted on the centre wall above the corresponding bus-bars, the connections therefrom running upwards and under the first floor to the oil switch terminals, thence down one or other of the intermediate walls to the current and protective transformers, and finally through the wall to the outgoing cable boxes.

The bus-bar selector and split conductor earthing switches are of the lever pattern, operated by means of handles external to the cells. An indicator lamp adjacent to the operating handle lights up when the oil switch of a particular circuit opens, so that the operator can tell if the circuit is disconnected from the bus-bars without having to make a special journey to the control room.

The generator control panels, together with the Tirrill regulator panels, engine-room telegraphs and control pedestals for the electrically operated field rheostats, constitute one of the L.T. boards; the feeder control panels are arranged in a semi-circle as a separate board facing the generator control board. Duplicate synchronising equipments are provided, and so connected that only one synchroscope can be plugged on at a time, the other acting as a standby. Large scale bus-bar voltmeters are arranged to indicate the voltage on each set of bus-bars. In order to facilitate synchronising a special voltmeter is provided for indicating the difference between the incoming machine voltage and the bus-bar voltage.

All generators are provided with balanced current protective gear which functions instantaneously in the event of a fault in the machine winding or cables between the machines and the switchgear cell. Automatic field suppression switches are provided so as to kill excitation after the generator oil switch has been tripped by the operation of the balanced current protective relay. A neutral point earthing resistance is provided for each machine, together with an oil immersed hand-operated isolating switch.

In order to provide against sustained faults on feeders and faults on the station bus-bars, each generator is equipped with a definite time limit overload and earth leakage standby relay. The rotary converter transformer feeders are provided with inverse time limit overload protection, whilst the outgoing feeders are all protected by the split conductor system with non-reactance type protective transformers and split contact oil switches. Definite time limit overload and earth leakage standby relays are also furnished on each of the split conductor feeders, so that, in the event of

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an excessive overload or an earth fault outside the zone protected by the split conductor system, the feeder will be isolated after a predetermined time has elapsed.

The D.C. auxiliary board, which obtains its supply from two B.H.-T. rotary converters, consists of 16 panels, and is installed in the converter annexe. This board distributes power to the whole of the auxiliaries in the engine room. A second set of bus-bars is provided on this board and an interconnector to the old generating station, so that if necessary direct current can be exchanged at any time. Power for the boiler-house auxiliaries and coal-handling plant is taken by means of two feeders to two separate 7-panel distribution boards, situated in a sub-station between the two boiler-houses.

After H.R.H. had formally opened the new power station he proceeded to Messrs. Steel, Peach and Tozer's works at Templeborough, where he inspected an electric motor of 15,000 h.p. In this case also the electrical plant was supplied by the British Thomson-Houston Co.

A DEMONSTRATION WINDOW.

It has always been recognised that it is easier to sell by demonstration than by precept, and this is particularly true in connection with the sale of appliances for the lighting of shop windows. One may talk and write to the point of exhaustion without convincing the average tradesman that his lighting is not all that it might be. A demonstration either in his own window or in a special demonstration window will, however, very quickly make the shopkeeper realise the many advantages which may be secured by the use of modern methods.



DEMONSTRATION SHOW WINDOW AT THE B.T.-H. CO.'S LIVERPOOL OFFICE.

The picture accompanying this note is reproduced from a photograph (taken with a Brownie camera) of the demonstration window which has been fitted up in the showroom of the British Thomson-Houston Co.'s Liverpool office. The goods in the window were supplied and arranged by Messrs. Jacobs, the well-known biscuit manufacturers.

Three separately switched systems of lighting are installed. Firstly, in order to show how a window should *not* be lighted, two bare 100-watt gasfilled lamps are suspended on flexible cords in the middle of the window. Secondly, there are three 100-watt Mazda gasfilled lamps in Jupitor X-ray reflectors fixed along the top front edge of the window. This exemplifies the correct method of lighting a window by means of concealed units. Thirdly, there are two more 100-watt Mazda gasfilled lamps in Jupitor reflectors fitted with X-colour ray attachments. These two units are intended to be used in addition to the other three Jupitor units in order to produce appropriate colour effects. Slides of various colours can be fitted into the colour attachments, and one colour may be substituted for another within the space of a few seconds.

This demonstration window has proved highly successful as a means of interesting tradesmen in the question of correct lighting, and the advantages of coloured illumination. Electrical contractors are encouraged to bring their customers to see the demonstration, which rarely fails to induce them to spend money on new lighting equipment for their own windows.

Trade Notes.

The *Benjamin Bulletin* for June is, as usual, a pamphlet which will prove of direct interest to all who are believers in good and effective illumination, as well as the energetic pushing of specialities which hold a first-class reputation, such as those made by the **Benjamin Electric, Ltd.**, of Tariff Road, London, N.17. The articles in this issue deal with the Benjamin loom, which will prove an improvement of direct value to all users of Ford cars; a neat illustration of motor racing at Brooklands; an instructive chapter on how to sell goods; and an explanatory article on showroom lighting. The pamphlet is most certainly well worth asking for, and it will be sent free on application.

Sterling Leaflets Nos. 350 and 357 respectively describe the Sterling combined valve and crystal receiving set and the Sterling multiple connector for radio-telephones. The former has an approximate range of 150 miles, the wavelength being variable between 280 and 2,800 metres. The apparatus is entirely self-contained, working with a low-temperature valve requiring only a three-volt dry battery for the filament circuit, and which, together with the H.T. battery, is accommodated in the base of the cabinet. The crystal is entirely enclosed and fitted with semi-automatic adjustment. Tuning is by variometers. The Sterling multiple connector has been designed for inter-connecting up to six pairs of radio head or hand phones in series, enabling a corresponding number of persons to listen in on the same receiving set. It comprises a polished mahogany case with ebonite top, fitted with stud switch controlling six pairs of terminal sockets. The position of the switch determines and indicates the number of pairs of telephones connected. Copies of both leaflets may be had on application to the **Sterling Telephone and Electric Co., Ltd.**, 210, Tottenham Court Road.

Finance.—Congratulations, as usual, to the G.E.C. on the wonderful organisation and management which enables them to earn and pay dividends in these difficult times. The annual balance sheet has just been issued, and shows that the liquid resources of the company amount to £840,000, an increase of over £700,000 on the previous year. What is more, the chairman, Mr. Hirst, thinks there is a fair promise of an improvement in trade, and his remarks may generally be taken as a very reliable barometer. Depreciation has been allowed for most generously, while the item "goodwill and patents" still stands at the nominal figure of £1. At a rash venture one might think that figure could be increased by a full hundred per cent. and still find some venturesome financier willing to buy it. Who knows? The balance sheet is accompanied by a well-illustrated pamphlet entitled "The G.E.C. and its Products," which should help the shareholders to gain a modest idea of the immensity of the undertaking in which their capital is invested, and how they can best promote its interests.

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Reviews of Books, &c.

[Books noticed in this column will be sent from ELECTRICITY *Office to any part of the world, for the published price, plus ten per cent. for postage (minimum 2d.), and orders will be appreciated.]*

A FAIR WAGE. By Edward Batten, M.I.M.E., etc. (Pitman. 2s. 6d. net.)—This is a book which deals with a problem on which there are many diverse opinions. Mr. Batten very ably sets forth the case from various aspects, and everybody interested in the betterment of life generally in industrial circles is strongly advised to obtain the book and carefully read it, weighing each paragraph. The book is exceedingly well written in concise and very carefully chosen phrasing. In fact, it does not appear to contain a superfluous paragraph. Not only will it provide considerable food for thought, but the style is easy and certainly convincing. The problem dealt with is discussed from many standpoints, as obviously its ramifications are wide. Most certainly employers of labour in any capacity will have their outlook on the wage question widened, and in many instances they will be enabled to view their position from a new angle to the betterment of their employees and, we should think, to their own business. The wage question is a more serious one to-day than it has ever been, and, when ultra-Socialistic tendencies are scourging great nations, we cannot do more than say that Mr. Batten's very fair and reasonable suggestions are worthy of most serious consideration. Not only do we congratulate Mr. Batten on his book, but we should like to offer our thanks to Mr. Lachlan Macbean for urging the author to publish his valuable ideas in book form.

ALTERNATING CURRENT ELECTRICAL ENGINEERING. W. T. Maccall. 493 pp., about 350 figs. (University Tutorial Press, 15s. net.)—This volume, a companion book to the author's "Continuous Current Electrical Engineering," is on the same lines as that treatise, and it fully maintains the high standard established therein. The present volume is intended to serve as a text book on alternating current theory and practice for a three or four years' course in electrical engineering. For evening classes it is suitable for advanced grouped courses (T7 and T8), and for the higher certificates in electrical engineering. The first two chapters deal with the basic principles of alternating currents and series and parallel circuits. Polyphase systems are then considered, after which the author deals successively with all the main types of alternating current apparatus, viz., instruments, transformers, alternators, motors of all types, rotary converters and rectifiers. There are also chapters on A.C. transmission and the protection of circuits; on alternating current traction; and on the important subject of wave form and harmonic analysis. No attempt is made to deal with methods of design, though, of course, the principles underlying them are discussed fully. The basic principles and construction of the thermionic valve are dealt with, but telegraphy and telephony are not considered at all. The book contains no advanced mathematics, but it is a quantitative treatment of the subject, as distinct from a merely descriptive treatment, and a large number of worked examples and test problems with answers are given. It is unquestionably a sound and thorough treatment of the subject, and we believe that it will be found as useful to those engaged in A.C. power stations, substations and test rooms as to the students in evening classes and technical colleges.

NICKEL. By F. B. Howard White. 118 pp., 21 figs., 12 tables. (Pitman, 3s.)—The mining, refining and applications of nickel are comprehensively dealt with in a most readable form in this valuable addition to Pitman's well-known "Common Commodities and Industries" series of books. Little is generally known of the properties and uses to-day of this element, and it will no doubt come as a surprise to many to learn the great extent into which it enters in modern appliances. Interesting as it is to learn of the various processes of mining and refining the metal, we pass over this part of the book, as well as the sections relating to nickel coinage, cooking utensils, the hydrogenation of oils in the presence of catalytic nickel, and the various nickel steel alloys used in bridge construction as well as for armaments. The widespread use of three-electrode ionic valves has demanded the production of particularly pure malleable nickel, and this section will appeal to many interested in broadcasting; whilst, as nickel-chromium alloys are now universally used for the resistors in electric heating units, the information given on these is not without attraction to electrical heating engineers, though this section is not so full of detail as some of the others. Of especial value is, perhaps, the chapter on nickel plating, which, with its tables on and details of rolled and cast anodes, hints on solutions, current densities, etc., is most welcome. Although we cannot touch on anything like all the very important applications of nickel dealt with in the book, we heartily recommend it to electrical and mechanical engineers, as well as to the general public which takes an interest in the contributions of science and engineering to the advancement of civilised comfort and well-being.

MODERN LAND AND SUBMARINE TELEGRAPHY. By G. S. Macomber. Cl. 8vo, 89 pp., 59 illustrations. (Chicago, American Technical Society, 6s. 6d. net.)—This American work contains an excellent general description of the instruments used in telegraph work and gives also a fair number of circuit diagrams, including those of the systems which are more particularly in use on the enormous land line mileage of the United States. The opening chapter is historical and gives a brief but interesting account of the early inventions of Steinheil, Cooke, Wheatstone and Morse as applied to land wires, and then goes on to describe the attempt by Brett, Field and Bright to gain the necessary backing for the Atlantic cables which they foresaw would ultimately come into being. The future outlook of the telegraph is looked upon as being decidedly bright, and acknowledgment is made of the probability that in course of time the Continental Morse code may be substituted for the American Morse now almost exclusively used in that country. General chapters follow on land line construction, equipment, repeaters, duplex, quadruplex and multiplex systems, as well as various printing telegraph instruments, all being treated in a simple descriptive manner which should give the reader an idea of the main principles involved in each subject. The book is well printed and will appeal to telegraph and cable operators and engineers.

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G.E.C. LIGHTING AT LYONS' CORNER HOUSE.

The rebuilding of London proceeds apace, and large numbers of very fine new buildings are springing up in every quarter. It is very noticeable that in nearly every instance lighting installations of the most modern character have been adopted for both interior and exterior illumination, and as a case in point we refer to the new Lyons' Corner House in Coventry Street, which was opened on May 31. This restaurant bids fair to be one of the most popular rendezvous in the West End, and it has been lighted both internally and externally in a most lavish yet artistic manner, the whole of the electric light fittings for the ground, first and second floors having been supplied by the General Electric Co., Ltd.

Twenty-one electroliers were supplied for the ground floor, which is a handsome apartment, decorated in Louis XIV. style, and the electroliers are well in keeping with the decorations. In common with the other fittings described in this article they were specially designed for this building in the Fixtures Design Office of the G.E.C. in collaboration with J. Lyons and Co., Ltd. They are of heavy cast brass, finished French Ormolu, and are designed in strict accordance with the traditions of the period. They are equipped with satin finish and cut-glass panels, rich cut-glass bowls and fiddle-back lustres. Fifteen of the electroliers are 36 in. in diameter, the remainder being 27 in. in diameter. On this floor there are also 22 two-light and 3-light brackets to match the electroliers, these being also supplied by the G.E.C.



FIG. 1

Fig. 1 is a view of the first floor, designed in Empire style, and lighted by 15 specially designed electroliers carried out in this period. They are of heavy cast brass, finished French Ormolu, with satin finish and cut-glass ware. Fifteen 3-light brackets to match are also installed.

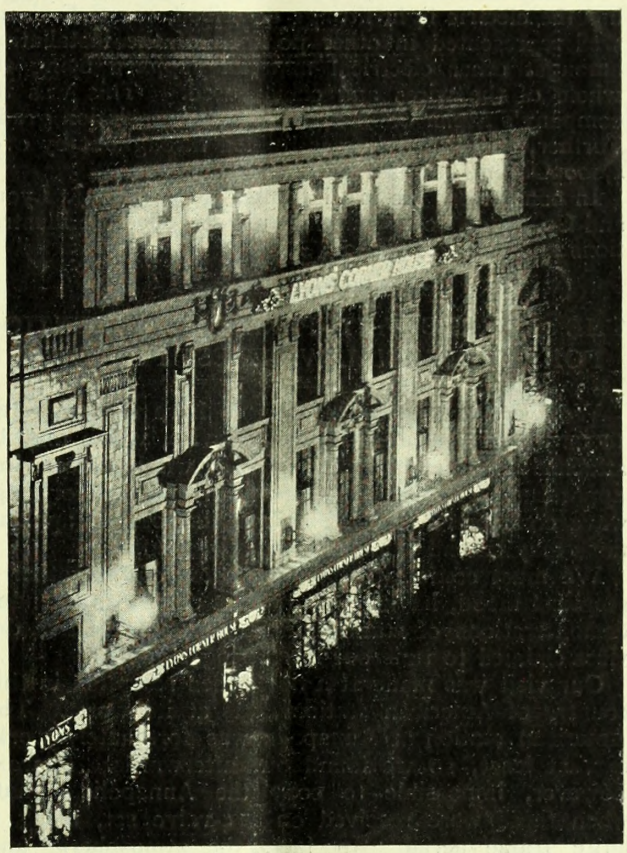


FIG. 2.

On the second floor the Adam style has been adopted, and fifteen suitably designed electroliers of heavy cast brass, finished Ormolu and equipped with satin finish and cut-glass ware, were supplied, together with 10 2-light brackets to match.

The staircases are lighted by 29 2-light brackets in rich French style and 24 bowl pendants of similar character suspended from the ceiling. A number of special brackets were also supplied for mounting over the doorways, these being of various patterns in conformity with the styles of their respective floors.

One of the most attractive portions of the lighting installation of the Corner House is the exterior illumination shown in Fig. 2, which is carried out by a number of G.E.C. floodlights. A novel feature of the installation is the method employed of illuminating

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the building from the opposite side of the road. The equipment consists of 25 floodlights, No. I.E.2/93, each containing a 500-watt Osram gasfilled lamp. These units are arranged in banks on the first floor of the building opposite, and are so focussed as to obtain an approximately even illumination on the face of the Corner House. There have been many notable attempts in the past year or so to floodlight buildings in this country, but in practically every case the installation has had to be mounted on the building in question, thus considerably restricting the possibilities of this method of lighting. The effects obtained at Lyons' Corner House, however, are particularly fine and mark a new era in floodlight practice. The restaurant is undoubtedly the most conspicuous building in London at the moment and is well worth a visit of inspection.

It may also be mentioned that, in addition to supplying the electric light fittings described, the G.E.C. are well represented in other portions of the installation, amongst other electrical material supplied being the whole of the wires and cables used. This was the company's Alpha Cable 2,500 Megs. Association grade. Further, all the building is lighted throughout by over 4,000 Osram gasfilled and vacuum lamps.

In conclusion, we are indebted to Messrs. J. Lyons and Co., Ltd., for permission to reproduce the illustrations and this description.

THE MARREC ANTI-PARASITIC INVENTION FOR COMMERCIAL WIRELESS PURPOSES.

We were privileged recently to have demonstrated to us the Marrec Anti-Parasitic device, which may be attached to practically any form of wireless receiving apparatus. The usefulness of this invention is for long-wave commercial work, although its possible applications may extend in many other directions.

We must confess to having started out in rather a sceptical mood, having on previous occasions attended demonstrations of static eliminators and selective devices claimed to tune out interfering signals.

Our visit was made at a time when reception in this country of American stations was at its worst. The American station at Annapolis was fortunately working, at least, so we found out afterwards. It was, however, impossible to copy the Annapolis signals when these were received on a 5-valve set, using a large frame aerial. In fact, the atmospheric and parasitic noises were so bad that it was more or less painful to keep the head 'phones on.

Perhaps at this stage we should add that the test was made in Holborn at a point where there must of necessity be a considerable amount of interference due to many local conditions.

It was just possible in the head 'phones to hear that a station was at work. When M. Marrec's device was switched into circuit, and the separate heterodyne slightly adjusted, the Annapolis signals came in clearly and sharply, but, wonderful to relate, there were no other noises of any kind present, and the signal strength, which under the circumstances of previous interference was most difficult to compare, was certainly louder when the interference noises were removed. The signal was then taken through further stages of low-frequency amplification on to quite an old type of Morse inker, which reproduced on the tape some of the most perfect Morse inker signals that we have seen produced by wireless means.

On switching back to the valve set, cutting out the eliminator, the inker refused to work and only gave a jumble of mixed up markings on the tape.

As a further test, two other stations very closely on the same wavelength were picked up, and it was demonstrated how very easily one station could be eliminated in order to receive the other, without interference.

Unlike many of the suggested eliminators, this apparatus is fitted in the terminal or output circuit of the receiving apparatus. It is not connected or fitted in the aerial side. It is also a complete and separate unit, which can be used with the set or not, as desired, and the unit can be instantly connected to any set, being complete in itself.

It has been suggested that the real test would be to put the apparatus down side by side and under the same conditions with one of the present commercial receiving stations, and to compare its working with such a set over a period. While we agree with this suggestion, we have no doubt in our own minds that the claims made are not exaggerated. If the device were connected to one of the standard high-speed relays and syphon recorders, or undulators, at present in use, one can readily understand how high-speed commercial transmissions could be received at a very fast speed with assured correctness, and the long-distance stations should not then have to close down during the congested hours of the day.

We have referred to other uses which the device could be put to, but we omit to mention these for certain reasons.

Our readers will appreciate that the actual method by which the result is obtained is not one that at the present time will be made public. The results, nevertheless, as far as our demonstration was concerned, appear to be there, and we feel sure that the general utility of the scheme will very quickly be acknowledged. We congratulate M. Marrec on his invention.

AN ELECTRIC GALLEY.

Some time ago a well-known Swedish shipowner stated that he was converting the galleys on all his motor ships to electric power. It was, therefore, interesting to note that on the motor ship "Tantalus," which is described in this month's *Motor Ship*, electricity is used wholly for cooking purposes, and we believe this is the first Holt liner on which such an arrangement has been employed. In their first motor ship, the "Medon," oil firing was adopted. The plant, which was built by Wilsons, of Liverpool, requires a maximum of 40 kw., which seems somewhat high, but this demand is, of course, not maintained for a long period. It seems open to doubt whether electric cooking represents an economy over oil firing, but it is certainly cheaper than coal, at any rate on a motor ship. The regulation is very simple, and one of the advantages is that when the requisite temperature is reached, the maintenance of this temperature is a matter of extreme ease, whilst for cleanliness and comfort to the cooks it will be difficult to improve upon the electrically fired galley.

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Throughout the whole of the accommodation, and in the seamen's quarters forward, which, incidentally, are extremely comfortable, heating is effected by electro-vapour radiators of the high-low type, which are now so frequently adopted on motor ships. They seem to afford an ideal solution to the heating problem, avoiding the necessity for maintaining steam in the boiler and having certain advantages over the radiant type for cabin use.

"M.W." PORTABLE BATTERY CHARGING SETS.

We have received a circular from M. W. Woods, 15/16, Railway Approach, London Bridge, S.E. 1, describing their portable battery charging sets for charging accumulators direct from electric supply mains. The machines described are the D.C. rotary transformer and the "M.W." rotary rectifier.

The former, illustrated in Fig 1, certainly solves the chief difficulty of charging accumulators off D.C. supply mains. This difficulty, as is generally known, is to reduce the supply voltage to a suitable pressure for charging. The usual practice is to insert a bank of lamps in series with the battery. This certainly meets the case, but it is very expensive owing to the enormous amount of energy wasted in the resistance. The machine can be obtained for supply pressures of 100 to 250 volts D.C.

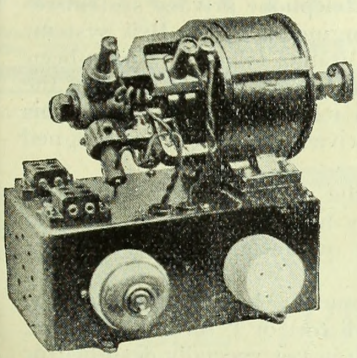


FIG 1.—No. 1 ROTARY RECTIFIER A.C. TO D.C.

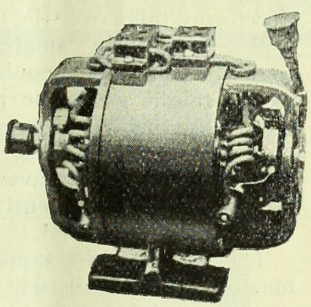


FIG 2.—No. 1 ROTARY TRANSFORMER D.C. TO D.C.
PATENT APPLIED FOR.

For the D.C. rotary transformer at a secondary output of 15 volts 3 amps. for charging 2-6 volt batteries, the power consumption is one unit in 8 hours, and for the No. 1 Rotary Rectifier, when charging 2-6 volt batteries at 3 amps. the input is one unit in 10 hours, giving overall efficiency of 36 per cent. and 45 per cent.

Fig 2 illustrates the "M.W." rotary rectifier, and it has been designed for use in the home and garage for charging accumulators off alternating current mains. The rectifier consists of a small synchronous A.C. motor fitted with a 2-part commutator, interrupting at such a point in the A.C. wave that full wave rectification can be obtained through the medium of three brushes.

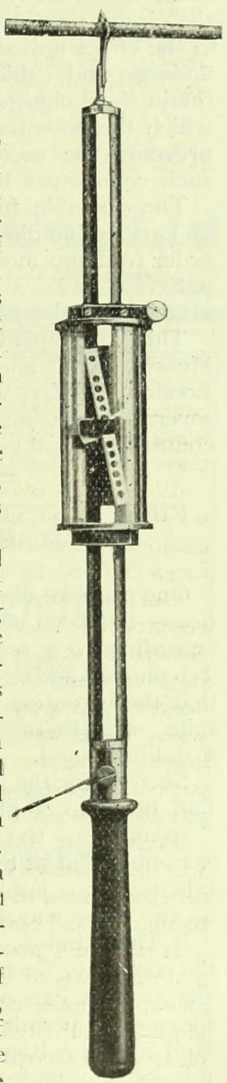
All machines are guaranteed for a period of twelve months from date of delivery, a recommendation in itself of the excellent quality of the material with which the machines are manufactured.

The prices of these machines vary according to their capacity, but, although they are more expensive than the initial cost of the usual bank of lamps, it will be found that they are really cheap in the long run.

THE "Sp" ELECTRO-STATIC POTENTIAL INDICATOR.

Users of high-tension current realise the necessity of knowing whether or not the circuit or apparatus is "alive," and often feel the need of a simple instrument which would enable them to see at a glance what conditions prevail. The makers of the "Sp" Electro-Static Potential Indicator claim that the instrument fully meets this requirement, and gives a clearly visible indication, at the same time taking no energy from the circuit.

The principle embodied is that the fall of potential along a tube of insulating material has, generally speaking, an even gradient. For instance, if 50,000 volts is applied to the ends of, say, a tube 50 cm. long, the fall of potential will be at the rate of 1,000 volts per cm. of length. If a metal pivot is inserted in the centre of the length of the tube and at right-angles to its axis, the difference of potential between this and either end will then be 25,000 volts. If this pivot has a metal needle of about 10 cm. length mounted on it, with a slight bias towards one side, then there will be an electro-static attraction between each end of the needle and the axis of the tube, due to the difference of potential of 5,000 volts, tending to turn it parallel to the axis of the tube.



In the practical instrument based on the above principle, a tube of special dark-coloured insulating material has a broad white line along its outer side with a considerable interruption in the centre of its length. At the centre of the interrupted line is a bridge carrying a free moving but slightly biased pivoted white aluminium strip, and a pointer, coloured red, fixed at a small angle to the axis of the tube. Midway along the tube is fixed a concentric glass cylinder supported between metal cheeks, which encloses the aluminium strip. Terminals are provided at the ends of the tube for the connecting leads, as shown in the illustration. If desired, however, a flange can be fitted at the lower end so that the instrument can be fixed at a vertical position, or a hook can be fitted at the upper end so that the apparatus can be hung on a high potential conductor.

The length of the tube varies in accordance with the maximum potential of the circuit, and six standard

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sizes are constructed, covering a range up to 80,000 volts. The various sizes are arranged so that the working pressures for which they are suitable overlap to a certain extent.

The indicators for the lower pressures have conductors carried some distance along the inside of the tube, so as to concentrate the fall of the potential in the vicinity of the aluminium strip.

When in use one end of the tube must be connected to the high potential line and the other to "earth," and, if the pressure be above the minimum for registration on the particular instrument, the aluminium pointer will turn towards the axis of the tube, its position relative to the fixed pointer being clearly visible. A relatively low pressure will cause the aluminium pointer to become parallel to the axis of the tube, thus making the white line continuous, and showing that the circuit is under pressure. On the other hand, very high potentials can be applied to the indicators. When the maximum pressure has been applied, the needle remains statically charged for some short time after the circuit pressure has been removed. This is similar to the effect noticeable on high potential overhead and underground cables, which, if isolated at both ends, retain their charge for a certain period, a phenomenon which the potential indicator takes regard of, and thus prevents the accidental and dangerous discharge of such conductors by personal contact.

The portable form, as illustrated, is provided with an earthed handle which is screwed on to one end. In order to damp movement due to vibration, the portable patterns have a powerful magnetic braking device attached to the pointer.

This instrument is being placed on the market by Messrs. Eck and Brook, of 4-12, Palmer Street, London, S.W.1, who state that it is being adopted by several large manufacturers of switchgear in this country, as well as by various central station engineers.

FILTER SYSTEM APPLIED TO RADIO TO SECURE SECRECY.*

One problem of radio telephony—privacy of conversations—has been solved by engineers of the Bell system, according to a recent announcement by the American Telephone and Telegraph Co., which reported that the invention was working successfully over a 30-mile stretch of ocean between Los Angeles and Catalina Island.

Secrecy for the "phantom wire," said the engineers, had been accomplished through an invention which "scrambles" the conversation at one end and "unscrambles" it at the hearer's end. The radio-telephonic talk is just a jumble to anyone else who "listens-in" on the same wavelength.

"The wireless 'talk bridge,'" said an engineer of the company, "which has given telephone service across the 30-mile gap of water, was designed and installed in 1920 to permit two-way talking between the mainland and the island. It has given satisfactory transmission day and night throughout the year.

"At the time the radio apparatus was installed a submarine cable could have been laid joining the island and mainland, which would have supplied a better grade of service at less expense. But the conditions at that time, which grew out of the war, were such that the manufacture of cable would have involved a long delay. However, suitable submarine cable will be available in the near future and will be laid to the island, but not before the new private radio system has received a thorough trial."

The radio system, even with privacy assured, can only be considered somewhat in the nature of a temporary affair. A cable could handle the messages more economically.

The installation of the cable will make the ether wavelengths now used by the radio system available for broadcasting or essential radio service.

The wireless link connects Catalina Island not only with Los Angeles, but also, through the trunk lines of the Bell system, with every commercial centre in the United States. After the laying of the telephone cable between Key West and Havana, the longest telephone circuit on record was set up between Catalina Island in the Pacific and the Island of Cuba in the Atlantic.

Starting from Catalina Island, the first 30 miles of this circuit were wireless; from Los Angeles to Key West, a distance of 5,000 miles, the transmission was by long-distance wires of the Bell system, and from Key West to Havana by 110 miles of submarine telephone cable.

The Catalina Island radio link is the first to be equipped with the wireless telephone privacy system recently developed by the engineers of the Bell system. Heretofore talks over the Catalina Island link have been "picked up" by amateur receiving stations in the region. The talker could not tell how far afield his words might go. The privacy system was designed to remedy this.

It is not claimed that the new system is absolutely secret, but at least privacy has been obtained, so that no one will inadvertently overhear the conversations which are transmitted.

The new radio equipment, before putting the messages on the air, will distort or "scramble" them, and no receiving set which is not specially designed or manipulated to "unscramble" them can obtain anything intelligible. While anyone familiar with the system, and possibly an ingenious person not familiar with it, might devise a set which could listen to the system, such a set would be much more complicated than the ordinary set, and the added complication would be of no value except for picking up transmissions over this system. It is, therefore, not likely that many people will try it.

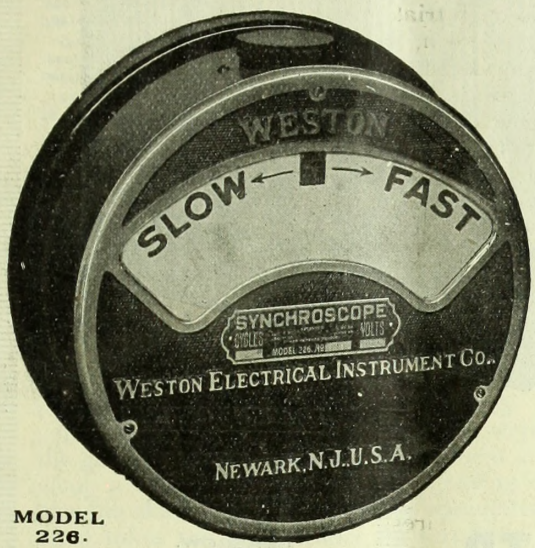
*Telephony (Chicago.)

Denmark.—The report on the economic situation of Denmark, which has just been issued by the Department of Overseas Trade (price 1s. 7d. post free from H.M. Stationery Office), shows that trade in that country is slowly but surely returning to its normal state, and that it will in due time require more British engineering products than it has been taking during the last two years of depression. This, of course, is a good sign.

The Inst. of Metals—Autumn Meeting.—The annual autumn meeting of this Institute will be held this year in Manchester on September 10-13, and will open with the second annual autumn lecture, to be delivered by Lieut.-Col. Sir Henry Fowler, K.B.E., on "The Use of Non-ferrous Metals in Engineering." The lecture will be a popular one, and is open to the public, tickets being obtainable from Mr. G. Shaw Scott, M.Sc., 36, Victoria Street, London, S.W.1.

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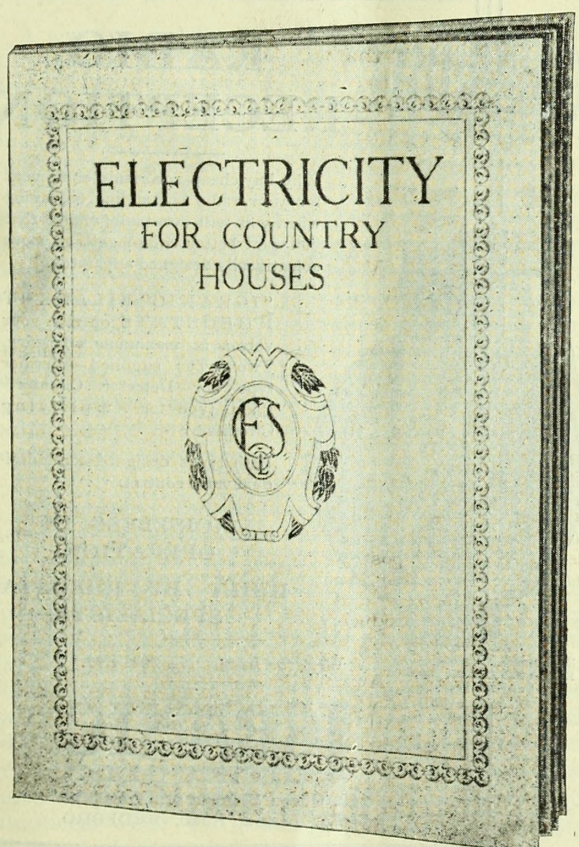
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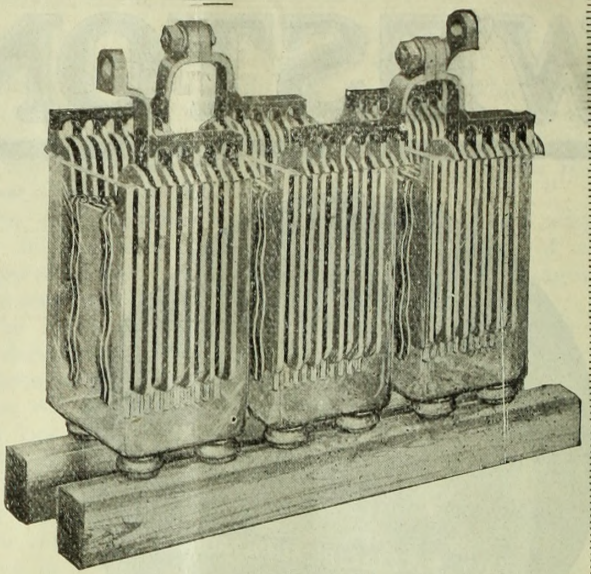
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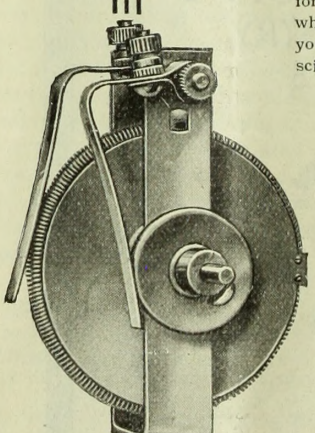
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Current Topics.

Summer at Last?

I am writing these notes in a sweltering, semi-tropical atmosphere, although, making due allowances for the vagaries of our climate, by the time they appear in print the compositors may have had to switch on the electric radiators in the composing room to thaw out their fingers. I wonder whether the purveyors of electric fans were ready with the goods? A hot spell like the present always brings along a welcome boom in electric cooling devices, but, like the skate trade, it is a very speculative affair and often takes the retail trader by surprise. I was in at a friend's office on the second day of the heat wave, and his electrician was vainly endeavouring to make a newly delivered fan function for the benefit of three sweltering typists. It was one of the newest and latest patterns, fresh from the stock shelves, and with its brasswork and lacquer untarnished. Yet, when plugged in to a near-by lamp socket and switched on, it resolutely refused to revolve.

I was pressed for time and could not stay to witness the subsequent investigation into the why and wherefore of this stubbornness, but, as I had previously seen a lamp alight in the same socket, can only presume the fan or its connections were at fault. In a perfectly new article, just delivered to meet a sudden emergency, this does not point to careful inspection or testing, and I was the more surprised in that the fan emanated from a first-class maker, whose name I will not divulge for obvious reasons. The trouble may have been quite simply accounted for by brushes sticking in their guides, or a starting switch connection loose, but the fact remains that this particular fan had not been turned out by its makers in good serviceable condition, and it is perhaps unfortunate that its first appearance in public should have been in the presence of an observant journalist.

Incidentally, this little episode goes to prove how necessary it is for the conscientious trader to check the condition of his stock from time to time, and, wherever possible, instal facilities on his premises for ensuring that the goods he is distributing are in good working order when they leave his premises. In these days of mass production and wholesale distribution north, south, east and west, goods, however carefully packed, are liable to suffer in transit. Sometimes vibration has a deleterious effect upon fragile electrical goods like lamps, wireless valves and the like, or small parts may come adrift in the packing cases and lie unnoticed when the goods are taken out and placed on the stockroom shelves.

Temperature and humidity also have their effects upon certain classes of electrical goods, and in any event it pays to make a rough test of all such articles immediately before delivery, and, if possible, in the presence of the actual customer, who is thus assured that they were in perfect order up to the time of handing over. To get an article home and then find, on connecting up and switching on, that there is a fault somewhere is most annoying, and calculated to destroy the user's confidence in the goods and their makers.

Electric Vehicle Control.

I am a staunch advocate of the electric vehicle for municipal and other public services, and have previously indicated in these notes those points where it scores over its petrol-driven competitor. Another of these advantages which the electric possesses has just come to light in the shape of what is known as kerbside control. In refuse collection, or any other house-to-house visitation, with frequent stopping and restarting, the petrol vehicle is at a disadvantage, due to the fact that its engine either has to be kept running for lengthy periods whilst the car is stationary, or continually stopped and restarted for the purpose of moving a few yards at a time. Moreover, the driver of a petrol vehicle must always be in the driving seat for the purpose of moving the vehicle, if only from one house to the next.

With the electric vehicle, on the other hand, starting and stopping are so readily accomplished and the control is so very simple that kerbside controls have been fitted to many of these vehicles, which enable the car to be started and moved short distances from the pavement, and without any necessity for the driver mounting to his accustomed seat. In fact, he can walk alongside and has a clear view of what is happening. The control of speeds, forward or reverse, is obtained through a horizontal handle, keyed to a spindle on an auxiliary controller, and in an accessible position at the sides of the vehicle. To provide against any possible abuse by unauthorised persons a change-over switch is provided inside the cab, which cuts out either or both controllers. A hand-brake lever is also fitted. In addition to leaving the driver free to perform other duties, this kerbside control is of considerable service in facilitating the movement of the vehicle in narrow streets or entries, where the view from the driver's normal seat or cab is obstructed.

Banish the Sun.

The sun and natural daylight, although extremely healthful, and in ordinary circumstances far preferable to artificial illuminants, not excepting electric light, are nevertheless harmful to certain of the world's treasures, especially those objects which are stored in some of our best known museums, natural history collections and the like. For this reason my Chicago contemporary, the *Engineering World*, foreshadows windowless buildings for housing these collections to ensure their greater preservation over a longer term of years. "Light is the great enemy of natural history collections. The lovely Luna moth fades after a few day's exposure; feathers of humming birds actually seem to disintegrate on long exposure to light; a few years ruin mammals, like deer and foxes.

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Even certain minerals are affected by light, and rose quartz pales in the sunshine and must be kept in the dark." Ultra-violet rays are said to be responsible for the damage, and all attempts hitherto to filter them out of natural light have been unsuccessful. Electric light does not injuriously affect these specimens so that the architects of future museums may specify electric lighting for these and similar buildings in which valuable specimens are exposed to public gaze.

Wireless Aerials.

The rapid growth of amateur wireless aerials in and around populous districts has prompted the Urban District Councils' Association of England and Wales to instruct its Executive Council to consider, from the point of view of supervision by local authorities during erection, the safety of these overhead collectors of broadcast music and speech. That some wireless aerials are erected in a very haphazard and insecure manner is doubtless true, since the average householder is no adept at climbing over roofs and driving spikes into brickwork, but in the majority of cases there is little risk to the public due to the comparatively short span of exposed conductor and the fact that most aerials lie within the confines of the property to which they are attached.

If an aerial should come to grief it is more likely to damage the house or roof to which it was originally attached than any passer-by, and the one individual most closely interested is the owner of the property, or a disinterested tenant of the same building whose windows might be broken by the falling wire or attached insulators. Unlike standard telegraph and telephone line construction the wireless aerial, as permitted under the British Broadcasting licence, is quite a light construction calling for no heavy poles or iron work, and it would be a thousand pities still further to handicap the progress of broadcasting by imposing grandmotherly restrictions or costly specifications on the holder of a ten shilling licence.

Since the efficiency of his reception depends upon the security of his aerial, the average amateur listener-in can be relied upon to make the best possible job of this vital factor in his installation, or, if he does not possess the necessary ability to erect it himself, to call in competent, professional assistance. If officialdom does impose vexatious restrictions, then it will be a case of increasing one's valves and installing an indoor aerial, of which there are many types already available.

To Wembley in 1924.

I note with pleasure that the E.D.A. proposal for a co-operative electricity supply display at the British Empire Exhibition next year is being enthusiastically supported by engineers of municipal and company supply undertakings in all parts of the country. In fact, the industry is preparing to demonstrate that, just as "Electricity" has been and is an all-important factor in assisting the post-war revival of Britain's industries, so it is destined to raise the standard of health, comfort and efficiency in British homes. "Electricity" will be there. Already in the short space of time since the launch of the appeal by the E.D.A., *some twenty-three supply undertakings have pledged their support; definite promises of recommendation have been made by several other authorities and companies.* Undoubtedly the weight of the whole of the supply industry must be put into this venture, and time is of the utmost importance. I hope, therefore, that I shall soon be able to make even more satisfactory announcements.

ELEKTRON.

TELEGRAPHY.—GRADE I. (1923).*

Being Solutions to the Questions set by the City and Guilds of London Institute in the Grade I. Examination in Telegraphy held in May, 1923.

(*Continued from page* 352.)

Q. 2.—Describe with sketches the principle and construction of a double-current key with switch.

*A.*2.—The plan of a double-current key is shown in Fig. 1. It has five terminals, of which *Z* and *C* are connected to the opposite poles of the signalling battery. Terminals *U* and *D* are joined respectively to line and earth or *vice versa* according to whether the key is at a down or up station.

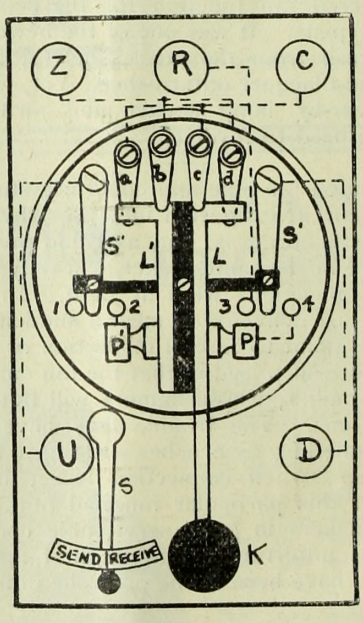


FIG. 1.

The key itself consists of two brass levers *L L'* insulated from each other by ebonite and pivoted at *P P'*. These levers are furnished with contact points which play between the contact springs *a b c* and *d*. *S'* and *S"* are switch levers insulated from each other but connected mechanically and controlled by the switch *S*. When *S* is in the "send" position the switch levers *S'* and *S"* make contact with studs 2 and 4 respectively, and if the key lever is in its normal

* *The standard text books for this Grade are: "The Telegraphists' Guide," by Bell & Wilson (20th thousand, 3s. 6d. net), and "Questions and Solutions in Telegraphy and Telephony, Grade I." by Few (5th edition, revised, 5s. 6d. net).*

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position levers L and L' are in contact with springs a and d respectively, thus connecting Z through the key to D and C to U. The depression of the knob K of the key causes L and L' to break from springs a and d and make contact with b and c. Z is then connected to U and C to D so that in this manner the current flowing to line may be reversed in direction by operating the key. On moving the switch S over to the "receive" position the switch levers S' and S'' leave studs 2 and 4 and make contact with studs 1 and 3, thus disconnecting the key levers L and L' and joining terminal R to D.

The receiving apparatus is connected externally to terminal R, hence it may be joined at will in place of the battery to the line by means of the switch S.

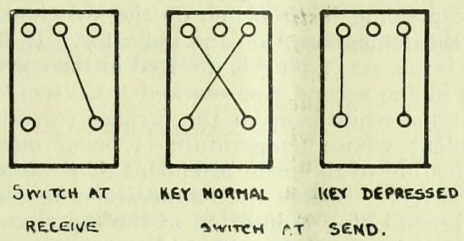


FIG. 2.

Fig. 2 shows the skeleton internal connections of the key for the various positions of the switch S and the key lever.

Q. 3.—Describe with diagrams the megger. How would you use it to measure the insulation resistance of a line?

A. 3.—The megger is practically an ohmmeter and generator combined and the principle of the instrument

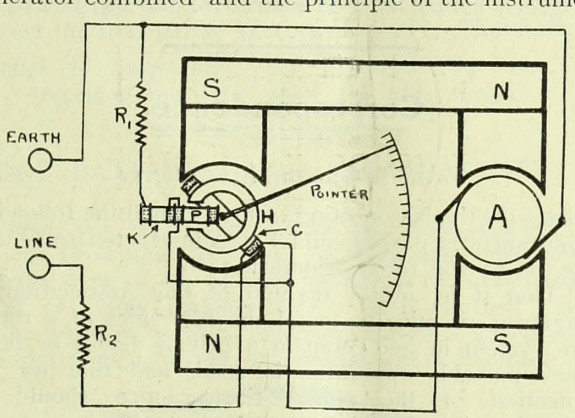


FIG. 3.

is shown in Fig. 3. SN,.NS are powerful bar magnets fitted with soft iron pole-pieces, the faces of which are hollowed out. In the space between one pair of pole-pieces is pivoted a low-resistance coil C, termed the "current" coil; and fixed to the latter, and making an angle of about 50 deg. with its plane, is a smaller coil P of high resistance, which is termed the "pressure" coil. In order that the magnetic field in which the coil system moves may be very intense, a hollow iron cylinder H is fitted between the pole pieces. It is necessary to protect the pressure coil from the influence of external magnetic fields, and to this end a "compensating" coil K, in series with it, is fixed on the end of the pressure coil, and so joined up that any E.M.F. induced in the pressure coil is balanced by the equal and opposite E.M.F. induced in the compensating coil. This precaution is not necessary with the current coil because it is wholly within a field of large and uniform intensity. A pointer fixed to the coil-system moves over a graduated scale. The other pair of pole-pieces forms part of the field magnets of a continuous current generator, the armature A being suitably geared to a crank for driving by hand.

The "current" coil is joined directly to the terminals of the generator like an ammeter, while the "pressure" coil is joined in shunt across the generator like a voltmeter. Compensating resistances R_1 and R_2 are connected in the circuits as shewn. When a circuit of high resistance is joined to terminal L, and the handle of the generator is turned, the "pressure" coil gets nearly all the current, and it tends to set in the gap with its axis at right angles to the direction of the magnetic field; while if the line resistance be small, a large current passes through the "current" coil, which tends to move in a direction opposed to that of the "pressure" coil. The actual position taken up by the moving coil system is the resultant of these forces.

In the constant pressure type of instrument generally used by the Post Office, the generator produces a voltage of 250 when the handle is turned above the slipping speed of the centrifugal friction clutch by means of which the generator is driven.

The type of megger used for maintenance testing is known as the "Bridge" megger, which combines the function of a megger with those of a Wheatstone Bridge. The changes in the internal connections are made by means of a two-way change-over switch which can be set to "Megger" or "Bridge." When the switch is turned to "Bridge," the generator connections are altered; the voltage is reduced to 125, and the instrument may be used as a Wheatstone Bridge. There is also a "ratio" switch which is used for varying the proportions of the two ratio arms. This switch may be used in three positions, viz., with its pointer at 1, 10, or 100. The plan of the top of the

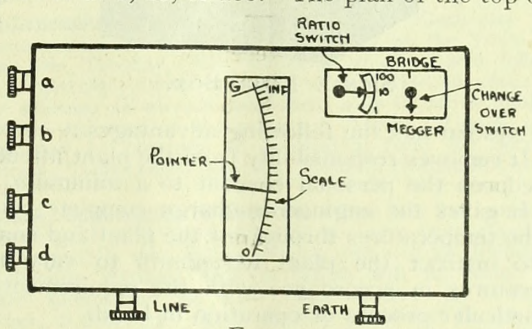


FIG. 4.

Bridge Megger is shown in Fig. 4. When the instrument is being used as a bridge, the change-over switch is turned to "Bridge," and an adjustable rheostat joined to the terminals a and b. The resistance under test is joined to terminals c and d. The handle of the generator should be turned slowly in a clockwise direction, and the resistance in the rheostat raised step by step from zero until the pointer rests exactly on the line marked G on the scale. The handle should then be turned at full speed in order to make final adjustments to the

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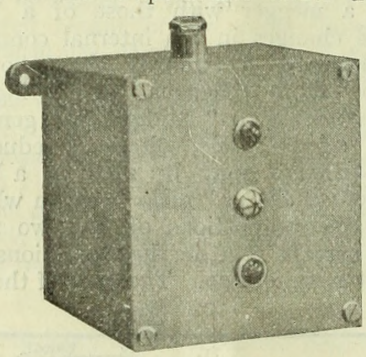
rheostat if necessary. If the resistance to be measured is less than 100 ohms, the ratio switch should be moved to 10 or 100. The value of the resistance in such circumstances would be equal to the resistance in the rheostat divided by 10 or by 100 respectively.

To measure the insulation resistance of a line, the change-over switch is turned to "Megger." The line, the distant end of which must be disconnected, is joined to the terminal marked "line,' and the terminal marked "earth" is earth connected. The generator handle is turned at an increasing speed until the clutch is felt to slip. The position of the pointer on the scale indicates the total insulation resistance of the line. The insulation resistance per mile is calculated by multiplying the total insulation resistance by the length in miles of the line.

(To be continued.)

THE SIEMENS LAMP SIGNALLING SYSTEM FOR PYROMETER INSTALLATIONS.

These switchboards and lamp signals, which are manufactured at Woolwich by Messrs. Siemens Bros. and Co., Ltd., enable the temperature at a number of distant points to be measured and *controlled* from one central position. The engineer-in-charge can read all temperatures on the indicator in his office or other convenient position, and at the same time, by a simple system of coloured lamp signals, keep the plant attendants constantly advised as to the regulation and maintenance of the temperatures under their control.



SIGNAL LAMP BOX.

The system has the following advantages :—

(1) It removes responsibility from the plant attendant and reduces the personal element to a minimum.

(2) It gives the engineer-in-charge complete control over the temperatures throughout the plant and enables him to instruct the plant attendants to vary their temperatures in accordance with the requirements of the particular process or operation in hand.

(3) It avoids the necessity of issuing complicated instructions to the plant attendants and of requiring them to think in temperature degrees.

(4) The system can be applied to any existing system of pyrometers.

A complete installation consists of the following parts :—

(1) A temperature indicator and switchboard with lever switches for connecting the indicator to any desired pyrometer.

(2) A pyrometer or distance thermometer for each point at which the temperature is to be measured.

(3) A switchboard with three rows of plugs and jacks for controlling the lamp signals.

(4) A signal lamp box for each point to which signals are to be transmitted.

(5) The necessary connecting cable.

If the system is to be adapted to an existing pyrometer installation, only items 3, 4 and 5 will be required. The apparatus consists of a wall type indicator, lever switches for six pyrometers, plugs and jacks for six signal lamp boxes, all mounted on a teak panel. Each lamp signal box is fitted with a red, white and green lamp, as illustrated. The current for the lamps is usually supplied by a 4-volt accumulator, but if desired arrangements can be made for running the lamps off any existing supply circuit.

The temperature at any point is measured by closing the corresponding lever switch on the switchboard and reading the temperature on the indicator. If the temperature is correct, a plug is inserted in the corresponding jack in the second row marked "Correct," which will light the white lamp at the furnace (or other part of the plant whose temperature is being measured), thus indicating to the plant attendant that the temperature is correct. Should the temperature be somewhat high, a second plug is inserted in the top row marked "High." The red light will then light up in addition to the white light, indicating that the temperature is still within permissible limits, but is approaching the high side. If the temperature becomes too high, the plug in the second row is withdrawn; this causes the white light to be extinguished, leaving only the red lamp alight, thus indicating that the temperature is too high. A similar procedure is followed when the temperature is too low, the only difference being that the bottom row of jacks marked "Low" (which operate the green lamps) is used instead of the top row.

Correspondence.

To the Editor of ELECTRICITY.

SIR,—At the last meeting of my Council the following resolution was passed, and I was instructed to send a copy on to you for consideration :—

"That it is, in the opinion of this Association, a dangerous practice to instal the two sides of a three-wire system in one room in a private house or office where portable apparatus is used, and that for the protection of the public the practice should be discontinued.

"This Association is anxious to do all that is possible to develop the use of electricity for domestic purposes and to make it safe for the public, and submits for consideration that the balancing of one house or flat against another will give a far more effective balance than the manner now adopted by some supply authorities."—I am, Yours faithfully,

LEONARD G. TATE,
General Secretary,

The Electrical Contractors Association (Inc.).
15, Savoy Street, London, W.C.2.
July 5, 1923.

[In our opinion the suggested alternative is a wise precaution, but we cordially invite correspondence on the subject.—Editor, ELECTRICITY.]

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Questions and Answers by Practical Men.

RULES.

QUESTIONS: *We invite our readers to send us questions, preferably on technical problems that have arisen in actual practice. Questions which we consider of sufficient interest to our readers will either be replied to under "Answers to Correspondents" or replies will be invited from our readers. One shilling will be paid for the question which we select for competitive replies in this column.*

ANSWERS: *A fee of 10s. will be paid for the answer which we consider shows the greatest merit, and 5s. for the one we select as second best. In judging the replies, importance will be attached to clearness and conciseness, as well as accuracy. The Editor reserves the right to make no award, or to accept only one reply, if, in his opinion, the answers received do not possess sufficient merit. Competitors desiring the return of their manuscripts, if unaccepted, should enclose stamped addressed envelope.*

Write on one side of the paper only, and if diagrams are sent, draw them on a separate sheet of paper attached to the manuscript. Competitors may adopt a "nom de plume," but, both in the case of questions and answers, the competitor's real name and address must be sent with the manuscript as a guarantee of good faith. No correspondence will be entered into with regard to successful replies. The Editor's decision is final.

Commencing with Question No. 101, a Diploma of Merit will be awarded to the six competitors who win the first or second prize the most times during the next twelve months.

The words "Questions and Answers" or "Q" and "A" should be placed at the top left-hand corner of all letters intended for this column.

QUESTION NO. 163.

I have a room 32 ft. long and 18 ft. wide. I wish to light it with electric light. I wish to produce about 6-foot candles intensity at the working plane, about 4 ft. from the ground. I would appreciate details of how many points to fit and the candle-power of the lamps.—"CUTTER."

QUESTION NO. 164.

I have an electric iron, but it has gone wrong. I have opened it out, and I find that the element is what appears to be aluminium paint on mica. I also notice that the circuit through this paint is interrupted. Since I cannot purchase a spare element, is there any means of repairing the defective element? If not, how can I convert the iron to use another element?—"LAUNDER."

(Replies to Questions Nos. 163 and 164 must be received not later than July 28, 1923.)

DRY BATTERIES FOR BROADCASTING.

Leaflet 595, III., which has just been issued by Siemens Bros. and Co., Ltd., of Woolwich, deals with a special type of dry battery for use in the low-tension circuit of "low temperature," "dull emitter" and similar types of wireless receiving valves. The use of such batteries is often of considerable advantage to



those who find it difficult or impracticable to get accumulators recharged, or who prefer a battery which does not require any particular attention, whether in use or not. The leaflet gives full particulars as to voltage, dimensions, weights and prices of the four different standard sizes which are manufactured, and the illustration shows its general appearance.

Various Items.

Dividend.—The Marconi International Marine Communication Co., Ltd., announce a final dividend of 7½ per cent., which, together with the interim dividend already paid, will make a total of 12½ per cent. for 1922.

Tenders Wanted.—The Sydney Municipal Council invite tenders for storage batteries, regulating switches, copper connections, charging boosters and switchgear. Specification, etc., at the D.O.T. (Room 52), 35, Old Queen Street, London, S.W.1.

Progress.—The annual report of Edmundson's Electricity Corporation, Ltd., discloses an increase of over £20,000 in the net profits, and a dividend of 7 per cent. on the ordinary shares is to be paid, leaving nearly £23,000 to be carried forward.

The L.C.C. and Wireless.—The L.C.C. have approved, for the guidance of the Council's officers, certain precautions which must be observed in connection with the installation of wireless apparatus at premises licensed by the Council for public entertainment.

North Wales.—The Electricity Commissioners have duly published the order constituting the North Wales and South Cheshire Electricity District and establishing the joint electricity authority therefor. Copies may be obtained from the Secretary at Gwydyr House, Whitehall, London, S.W.1.

The "Henley Telegraph."—The issue of the *Henley Telegraph* for March-June, 1923, is full of interesting text dealing with the doings of the staff of this great cable-manufacturing organisation, and will, we are certain, be appreciated by all the readers at the Henley head office, factories and branches.

China.—The Magistrate of Shanghai is in receipt of an order from the Kiangsu Industrial Commissioner instructing him that hereafter all electric enterprises in Shanghai must be approved by the Ministry of Communications, and no such companies are to be allowed to start business before proper sanction has been granted by the Ministry.

Tenders Invited.—The State Electric Light Works at Montevideo invite tenders for electrical accessories, of which full particulars may be obtained from Room 52 at the D.O.T., 35, Old Queen Street, London, S.W.1.——Also the Victoria Govt. Rys. invite tenders for three-phase A.C. induction motors, starting apparatus and accessories. Particulars from the D.O.T., as above.

Jugoslavia.—The report on trade conditions in the Serb-Croat-Slovene Kingdom has just been issued by the D.O.T., and may be obtained from H.M. Stationery Office or from ELECTRICITY Office, price 1s. 8d. post free. It shows that trade is making quiet but steady progress in that country, and it is to be hoped that more business will be done with Great Britain in the near future.

Mid-Lancashire Electricity District.—The Electricity Commissioners intend to hold a local inquiry at the Town Hall, Preston, on Tuesday, July 31, at 10.30 a.m., and following days, if necessary, with reference to the Mid-Lancashire electricity scheme, as already published, and in order finally to determine the area of the proposed district. Copies of the scheme may be obtained on application from the Secretary, Electricity Commission, Gwydyr House, Whitehall, London, S.W. 1.

B.E.S.A. Specification Withdrawal.—The B.E.S.A. announces the withdrawal of B.S. Specification 72—1917 from circulation. This document is now under revision and will be divided into the following sections, each of which will be issued as a separate publication as and when ready:—(a) Industrial machines, B.S.S. 168—1923, already published; (b) large machines, (c) transformers, (d) rotary converters, (e) traction motors, in course of preparation.

Personal.—Mr. C. Y. Knight, chief London representative for the Morgan Crucible Co.'s carbon brush department, wishes to advise his friends of his new address—45, Leinster Avenue, East Sheen, S.W. 14. Telephone No. Richmond 2017.——Mr. E. P. Bennett, formerly joint general manager for Messrs. Simplex Conduits, Ltd., Birmingham, and who has recently completed a world circuit in the interests of Messrs. Simplex Conduits, Ltd., Credenda Conduits Co., Ltd., J. A. Crabtree and Co., Ltd., and other manufacturing concerns, has now joined the well-known firm of export merchants, Messrs. Cargills, Ltd., Balfour House, 119-125, Finsbury Pavement, E.C.2, as manager and buyer for the electrical and general engineering departments.

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Trade Notes.

A 4-pp. illustrated pamphlet which has just been issued by the **British Thomson-Houston Co., Ltd.**, gives details and prices of the Mazda gasfilled projector lamps with spherical or tubular bulbs and/or "bunch" or "grid" filaments. These lamps have been designed for use in projectors of various kinds, and should therefore be of direct interest to installation contractors generally, to whom copies of the list will be sent on receipt of proper trade application.

A postcard circular issued by the **Cambridge and Paul Instrument Co., Ltd.**, of 45, Grosvenor Place, S.W. 1, gives illustrations and details of the Weston Normal standard cells as manufactured at the company's works.

A new catalogue of "Xcel" electric heating and cooking appliances has just been issued by the **Automatic Telephone Mfg. Co., Ltd.**, of Milton Road, Edge Lane, Liverpool. It is excellently printed and illustrated, and gives details of the various "Xcel" specialities which the company have been manufacturing regularly for the last eight years and advertising so widely under the trade mark referred to. These appliances include such good selling lines as irons, boiling rings, kettles, cookers and fires, all of which are clearly described in the pamphlet, and as they all carry a generous guarantee they represent lines which can always be relied on to sell well. The list should therefore prove of direct value to all retail dealers in such goods, and the company will be pleased to send a copy on application to any regular trade dealer. It is well worth writing for. In fact, so firm a faith have the company in their products that they are prepared to give a guarantee for all time for the life of the element in connection with their electric irons Nos. H 496 and H 350. This, they believe, is unique in the trade, and it should certainly be of interest to our readers.

The July issue of the Sunco Monthly Stock List should have reached the majority of the clients of the **Sun Electrical Co., Ltd.**, ere this notice appears in print. All prices are the latest and lowest consistent with quality, and some special lines are offered at bargain prices.

An excellent catalogue of reflectors and their units for use with electricity has just been issued by **Holophane, Ltd.**, of Elverton Street, London, S.W. 1. It contains sections dealing with the various types of glassware designed for different classes of illumination, which makes it much easier for reference purposes. There is also a special section devoted solely to useful illuminating engineering data.

Circulars Nos. 86 and 87, which have just been issued by the **Consolidated Pneumatic Tool Co., Ltd.**, deal respectively with accessories, such as indiarubber hosepipe, safety couplings, tube cutters, etc., and with the company's power-driven air compressors for use with pneumatic machinery. They are well printed and will doubtless prove of interest to all users of pneumatic tools and drills.

Sterling Telephone and Electric Co., Ltd., issue two recent publications dealing with their wireless products, No. 360 being a single leaflet illustrating the Sterling high-tension smoother, an apparatus which has been designed to enable users of valve receiving sets requiring a plate voltage of from 100 to 300 volts to dispense with the usual high-tension dry batteries and take the necessary current supply from their D.C. electricity mains where available. Where this method is adopted, the Sterling smoother is designed to ensure freedom from hum or other undesirable noises. It is a well-made instrument, entirely shock-proof, the containing case being highly finished black stove-enamelled steel. It is fitted with three condensers, four choke coils, two lamp sockets and a double-pole push-button switch, the lamps used being those employed on the ordinary lighting circuit, which give a visual signal in the event of a short circuit. Publication No. 361 is a well-illustrated brochure dealing with radio in summer-time. It embodies all the standard Sterling receiving sets, loud speakers, power amplifiers, etc., and is interspersed with ten appropriate line sketches showing the adaptation of wireless to such summer recreations as boating, tennis, motoring, caravanning, etc. It is highly suitable literature for distributing among traders at the present season.

Fescol, Ltd., of Penarth Street, Canterbury Road, London, S.E.15, are specialists in electro-chemical deposition, and will be pleased to quote for any work of this description which may be required by our readers.

The July trade price list has been duly issued by the **Siemens and English Electric Lamp Co., Ltd.**, of 38-9, Upper Thames Street, London, E.C.4, and will, of course, be duly appreciated by all electrical contractors and retail dealers in electrical supplies.

Messrs. Cargills, Ltd., export merchants, Balfour House, 119-125, Finsbury Pavement, E.C.2, would be glad to receive from manufacturers latest catalogues and leaflets illustrating and describing their products, together with lowest export terms and prices, and to be kept regularly posted with advertising matter and notified of all fluctuations in prices or discounts.

Various leaflets dealing with new plant and accessories have just been issued by the **Metropolitan-Vickers Electrical Co., Ltd.**, of Trafford Park, Manchester. They include 61/1—1, on industrial type drum controllers; 61/3—1, watertight type drum controllers; and 51/1—3, direct-current motor starters Type S.D. In addition, they send Circular 1061/1, which contains a full description of all types of their drum controllers. They will therefore be of direct interest to all traction engineers, as well as to electricians in charge of plant on ships, in mines, iron and steel works, and in industrial works generally, to whom the company will be pleased to send any particular list on application.

A well-printed catalogue has reached us from **Messrs. Evershed and Vignoles, Ltd.**, of Acton Lane Works, Chiswick, London, W.4. It deals especially with the various types of recording instruments manufactured by them, including ammeters, voltmeters and wattmeters, and gives clear and excellent descriptions of the mechanism and the methods of working. It should therefore be of direct interest to every central-station engineer and electrician-in-charge.

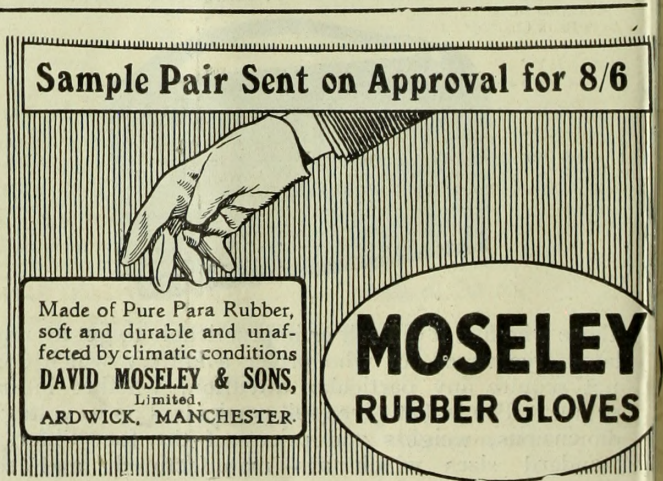
The Hart Accumulator Co., Ltd., of Stratford, London, E.15, announce a further reduction of 10 per cent. off list prices of their motor-car starter and lighting batteries from July 2. This reduction applies to all classes of batteries both for home and export trade. Large stocks of these batteries are kept ready for immediate despatch from any of the company's branches at Birmingham, Glasgow, Manchester and York.

A leaflet just issued by **Messrs. A. P. Lundberg and Sons**, of 477, Liverpool Road, London, N.7, gives illustrations and prices of their new special flush switches for wireless telephony. It should therefore appeal to a very wide circle of our readers, who should write and ask for it.

The Sun Electrical Co. announce that the branch office at 29, Park Place, Leeds, hitherto managed as an agency, is now under the direct control of the company, who have appointed Mr. David Fraser as branch manager to date from August 1, and in the meantime the service of the regular staff will be supplemented by regular visits by a responsible official from the head office. The depôt holds large stocks for the services of the company's Yorkshire clients, and it is hoped that they will make full use of the facilities offered.

Owing to the need of increased accommodation, **Messrs. Wm. Sanders and Co.**, Wednesbury, switchgear manufacturers, have transferred their London showrooms from 90, Charing Cross Road, to Palace House, 128, Shaftesbury Avenue. The telephone number remains the same at the new address—viz., Gerrard 8984.

Wanted for Canada.—A Canadian firm of manufacturers are desirous of receiving from British manufacturers quotations for varnished cloth tape, which they are said to buy in fairly large quantities. The name and address of the inquirers, together with further particulars, can be obtained by British firms in a position to offer British material on application to the D.O.T., 35, Old Queen Street, Westminster, S.W.1.



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A POPULAR SCIENTIFIC WEEKLY JOURNAL
ELECTRICITY
A PRACTICAL TRADE JOURNAL

JULY 20, 1923.

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ILLUMINATED ROAD DESTINATION SIGNS.

Sir Henry Maybury, of the Roads Department, Ministry of Transport, speaking on June 30 at the Urban District Councils' Assoc. Conference at Llandudno, urged the use of illuminated signs for the use of travellers at night. "There was," he said, "£1,500,000 available for local authorities, and authorities who wished to embark upon schemes should send their applications at once."

Everybody who has done any travelling at night by road has often experienced the annoyance and delay caused by having to stop and use a flashlight or a match at a corner in order to read a finger-post. It has been a sore point with motorists and other users of the roads that the public bodies concerned have been

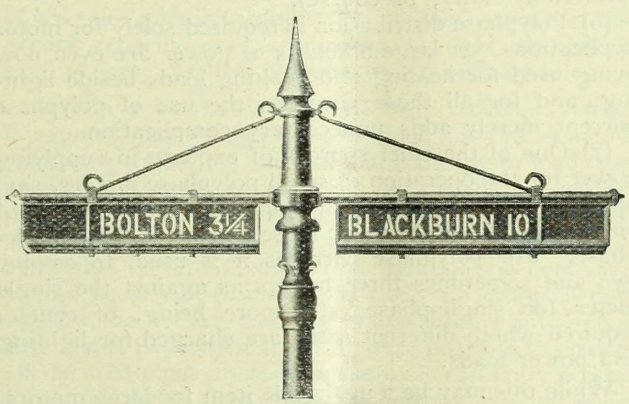


FIG. 1.—B.T.-H. ILLUMINATED ROAD DESTINATION SIGN BY DAY.

more or less indifferent to the growing demand for an effective night-time road indicator. The signpost in general use is often very indistinct even by day, and, of course, cannot be seen at all by night. The British Thomson-Houston Company have recently produced a sign which is permanent, and in which the lettering stands out quite clearly by day, while at night the letters are illuminated from the inside. One has already been erected on the Bolton-Blackburn road, and the local authority concerned is to be congratulated on an innovation which, it is hoped, will soon become general throughout the country wherever current is available.

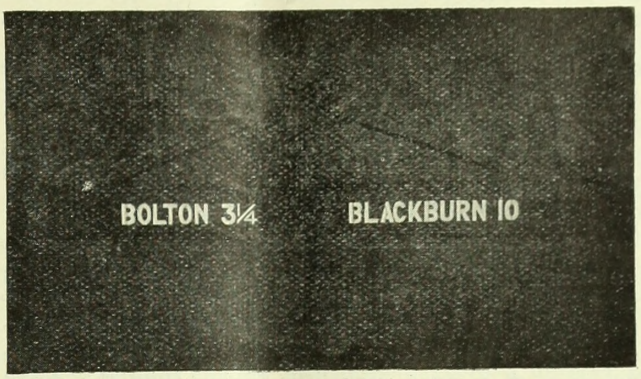


FIG. 2.—B.T.-H. ILLUMINATED ROAD DESTINATION SIGN BY NIGHT.

It is exceedingly strong, consisting of a massive copper box, the only movable part of which is the bottom, and can be attached to the usual type of post or any other convenient support. The letters are cut by stencil and backed with opal glass. A novel feature is the diffusion of the light so that the whole of the lettering is evenly illuminated. As a rule in this type of sign, bright spots appear immediately in front of the lamps, but in this case the lighting is absolutely uniform. From the photograph it will be seen how

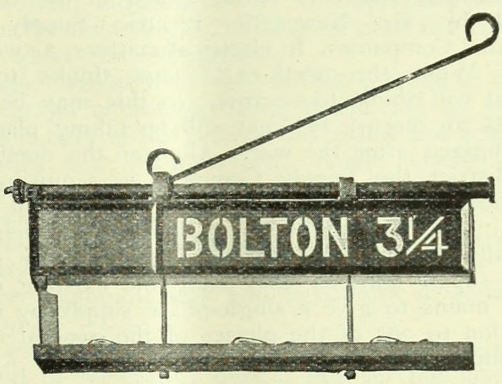


FIG. 3.—B.T.-H. ROAD DESTINATION SIGN, SHOWING THE BOTTOM LOWERED FOR CLEANING AND LAMP REPLACEMENTS.

clearly the words stand out when illuminated, and they can be read at night at the same distance at which they become distinguishable in daylight. The bottom, though not wholly detachable, contains the lamps, and is so made that it can be readily drawn down without disturbing the remainder of the sign or the wiring. This gives free access to the whole of the inside for cleaning, renewal of lamps, etc.

The British Thomson-Houston Company, Ltd., will be pleased to give full details and advice to all public bodies interested on application to any of their branch offices, or to Mazda House, 77, Upper Thames Street, London, E.C.4.

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SINGLE-PHASE COMMUTATOR MOTORS.

THEIR PROGRESS AND REASONS WHY THEY DEMAND THE ATTENTION OF POWER ENGINEERS.*

About four years ago the writer read a paper before this Association in which a description was given of the then position of the compensated single-phase motor, including a number of tests on machines as built at that time, and a full description of the principle of the machine and the various forms which it takes for different classes of commercial application.

Since that time, progress in the development in this type of motor has continued steadily, particularly in the direction of reducing the cost without any sacrifice of its useful qualities.

At the time the former paper was read, the writer felt in considerable doubt as to whether the cost could be reduced to that of the direct current motor, for instance, but this doubt has been dissipated by later experience, and it is now possible to produce these machines at a price very little higher than the direct current motor and quite as low as that of the old-fashioned type of single-phase machines.

These developments have rendered it possible to take advantage of the many useful features that the single-phase system has always possessed, which have been nullified in the past by the inferiority of the split-phase motor. In the previous paper the following statement was made:—

"The growth of the movement in favour of large power companies is likely to favour the installation of single-phase systems in residential and other districts where the motor load is not the chief part of the load. As an instance of this I may mention the movement of conversion which is taking place in the district covered by the Newcastle Electric Supply and Associated Companies. In electrical matters, as we well know, 'What the north-east coast thinks to-day, England will think to-morrow,' so this may be well taken as an augury of what will be taking place all over England after the war. All over the north-east coast district the Supply Company is acquiring the small independent supply schemes of the different small towns in Northumberland and Durham, which are practically all direct current, closing down the direct current supply stations, and using the existing direct current mains to give a single-phase supply by direct connection to one of the phases of the general three-phase supply system."

Since these words were written, this movement has taken on very much greater proportions and has extended from the north-east coast all over the country.

It has been thought, therefore, that a paper might be of considerable interest, describing the present position of the compensated type of motor and the revolution—for it is nothing else—which has been effected in the position of single-phase supply, which, instead of being regarded as condemned by the inefficiency of the single-phase motor, can now take its rightful place as the correct system for the supply of power to lightly loaded areas or areas where the motor load is not the predominating feature.

The single-phase system, as stated in the previous paper, has a definite place to fill in the system of electric power supply, which no other system can fill so well, and it is certain that single-phase systems will only be expanded by the extended use of electric power supply in all countries.

That the single-phase system has many advantages from a distribution standpoint has been recognised from the beginning, and if extending systems have been unable to take advantage of them the reason is to be sought in the inferiority of the old-fashioned split-phase type of single-phase motor, the supersession of which, however, is fortunately now imminent. We shall see later on some of the unfortunate results which flow from the large number of these motors which exist on every single-phase circuit.

It may be worth while to recapitulate briefly some of the advantages of single-phase distribution as compared with three-phase:—

(1) Cables containing equal amounts of copper are both simpler and cheaper when arranged for single-phase.

(2) The local wiring required is very much reduced owing to there being only two wires to be handled instead of three. In addition to this, jointing is very much simplified.

(3) The switchgear and protective apparatus is very much simplified. Although the single-phase generator costs more than the three-phase, the switchboard costs very much less, and this saving is found in many cases to more than offset the extra cost of the generator, the single-phase station for small capacities working out cheaper than the three-phase. Due to the advent of bulk distribution, small single-phase generators are being superseded, but local distribution switchboards are not, so the advantage of the single-phase switchboard remains without the offset of the more costly generator.

(4) For the same output single-phase transformers are distinctly cheaper.

(5) Three-wire single-phase systems are possible, exactly similar to direct current three-wire systems, provided the apparatus connected across them all operates at approximately the same power factor (preferably unity, of course).

(6) Polyphase distribution is required solely for motor applications, yet large amounts of power are even now being used for heating and cooking loads beside lighting, and for all these purposes the use of polyphase current merely adds unnecessary complication.

(7) One of the chief sources of expense in supplying power for the operation of small polyphase motors, say, up to 10 h.p., is due to the fact that the metering of polyphase currents is much more expensive than single-phase. For polyphase currents it is usual to employ two and sometimes three meters as against the single meter for single-phase, still more being, of course, required where different rates are charged for lighting and power loads.

While this may be a negligible item for large motors, it is very noticeable for motors of the sizes just referred to, and forms, in conjunction with the other sources of additional cost referred to above, a large part of the reason why many of the large power companies in the U.S.A. refuse to connect any polyphase motor of less than 10 h.p. to their polyphase lines, a practice which is beginning to make headway in this country as well.

It may be pointed out that the cost of the single-phase motor is not greatly in excess of the polyphase slip-ring type, while its starting is infinitely superior to

* A Lecture delivered before the N.A.S.E., by F. Creedy, Esq. A.M.I.E.E. A.C.G.I.

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that of the squirrel-cage type, and, in fact, it is often truly stated of any single-phase commutator machine that it disturbs one of the three polyphase lines at starting a good deal less than the squirrel-cage polyphase motor disturbs all three lines.

These advantages have hitherto not been available owing to the importance of the motor load to every supply authority, and the very low average power factor frequently not greater than .5 produced by the old-fashioned type of motor. It is pointed out below how serious is the effect of bad power factor on the cost of distribution, and such power factors as these more than offset all the advantages mentioned above, hence the well deserved disfavour in which this motor and consequently the single-phase system as a whole has been held. Even now the influence of power factor on the costs of distribution does not seem to be fully appreciated in all quarters. Compare, for instance, the case where a given power supply at .8 power factor requires, say, 100 amps., and supplied at 1.0 power factor, requires 80 amps. To produce equal heating in two cables carrying these currents, the one carrying 100 amps. must have 1002/802 equals 1.57 times the cross section of that carrying 80 amps. Both these currents correspond to the same kw. supplied, that is, both earn the same revenue, and hence the cost of copper to transmit the given power at .8 power factor is 1.57 times its cost at unity power factor. This is an example of the following general statement :—

The cross section of copper required to transmit a given power with a given loss (or heating) is inversely proportional to the square of the power factor.

The real seriousness of these consideration is marked by two facts.

(1) That the motor load on some single-phase circuits is not the chief thing. Unity power factor loads, lighting, cooking, heating, etc., may be greater than the motor load and thus prevent the power factor from getting too low.

(2) Mains are usually laid of greater capacity than is necessary at the moment when they are put down. If we take a short-sighted view it may seem that the excess capacity over requirements might as well be used to carry wattless currents as left entirely idle.

This is a very short-sighted view indeed, as when low power-factor apparatus is once on the mains it cannot easily be got off, and will continue to load them up with non-revenue producing current when a revenue producing load is immediately available. The writer knows of at least one case where a supply authority is compelled to refuse connection to would-be customers simply because the mains will carry no more current, and for the present the capital expenditure involved in new mains is prohibited. If it were possible to change all the split-phase motors on the mains to unity power-factor apparatus, it is estimated that the existing mains would still be 15 per cent. to 20 per cent. in excess of requirements, but, of course, some thousands of horse-power of motors of the old-fashioned type now on mains cannot be got rid of without very large capital expense.

For these reasons all supply authorities will ultimately be compelled to charge for the k.v.a., and not kw. supplied, as many do already.

(To be continued.)

TELEGRAPHY.—GRADE I. (1923).*

Being Solutions to the Questions set by the City and Guilds of London Institute in the Grade I. Examination in Telegraphy held in May, 1923.

(Continued from page 377.)

Q. 4.—What do you mean by universal battery working, single current working, series working, and leak working ?

A. 4.—*Universal Battery Working.*—To provide a separate battery for each circuit at a large telegraph office would be very costly owing to the number of cells required for the purpose. Moreover, the space occupied by the batteries would necessarily be considerable and the cost of maintenance high. In order to effect economies in these respects, it is now the practice to adopt universal battery working, which consists in using an arrangement of primary or secondary cells to supply current simultaneously to a number of circuits joined in parallel.

Central Battery Working.—This system of working is one in which the transmission of signals between all stations on one telegraph circuit is effected by using a single battery located at one of them. The station containing the battery is termed the Head Office in order to distinguish it from the others which are known as out-stations.

The great advantage of the system is the saving of battery maintenance at all except the Head Office, but another and almost equally important advantage is the simplification of the apparatus employed, which eliminates to a large extent the liability to faults due to incorrect adjustments by the operating staff and lessens the amount of technical knowledge and experience required at the out-stations.

Single Current Working.—In this method of working a telegraph circuit signalling is effected by applying one pole only of the battery to the line and apparatus, the other pole being earthed. Single current working at a high speed is not practicable over lines possessing appreciable electrostatic capacity.

Series Working.—This is a method of connecting up Wheatstone *A.B.C.* circuits, and consists in joining all the communicators and indicators in series with the line.

In general the term may be applied to any simplex method of telegraphy over a line serving more than two stations, the coils of the receiving apparatus and keys at all stations being joined in series with the line so that the same current works all instruments.

Leak Working.—This is the standard method of working Wheatstone *A.B.C.* circuits. The indicator at each station is not joined directly with the line, but is connected in a circuit in series with a condenser and resistance coil, teed off from the line to earth. A current flows along the line only when a station is sending, the condensers in the "leak" circuits allowing the passage of the alternating current generated by a communicator.

Generally, the term applies to all systems of working in which the coils of the receiving apparatus are not

* *The standard text books for this Grade are : "The Telegraphists' Guide," by Bell & Wilson (20th thousand, 3s. 6d. net), and "Questions and Solutions in Telegraphy and Telephony, Grade I.," by Few (5th edition, revised, 5s. 6d. net).*

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connected directly in the line, but are joined in a high resistance branch circuit teed off from the line, at the station, to earth. Only a certain proportion of the current from the sending end of the line passes through the receiving coils at each station.

(To be continued.)

A NEW ENGINEERING WORKS.

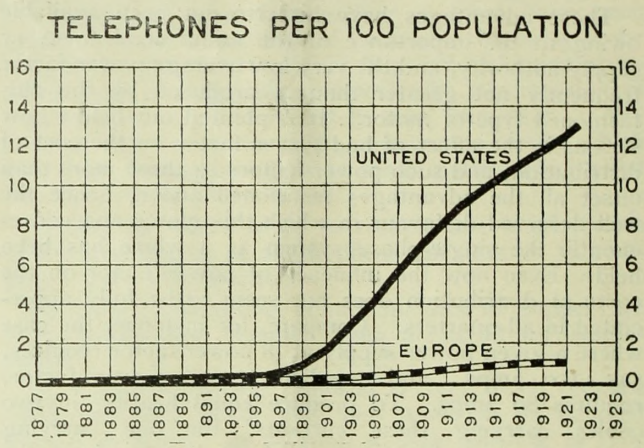
Messrs. The International Combustion Engineering Co., Ltd., who are the manufacturing company for Messrs. The Underfeed Stoker Co., Ltd., of London, have just completed the erection of a new engineering works at Derby, which is undoubtedly one of the most efficient in the world. It has been designed specially for the manufacture of a wide range of underfeed stokers, both for water tube and cylindrical boilers on land and sea, "Lopulco" pulverised fuel plant and appliances, air heaters, the water sluice ash conveyor and the many other specialities of the Underfeed Stoker Co., Ltd. The site, adjoining the London Midland and Scottish Line, is just outside the town of Derby, and covers 53 acres, the buildings comprising a block of drawing and general offices, a machine shop (226 ft. by 150 ft.), a foundry (262 ft. by 150 ft.), a pattern shop and pattern store, boiler house for heating purposes and transformer equipment, the whole works being electric driven with power from the Derby Corporation.

The foundry is undoubtedly one of the best equipped in the country, and a feature is the cupola heavy construction staging to accommodate two 15-ton and one 6-ton cupolas with large stocks of pig iron, coke and limestone always at hand, the material being handled by electric lifts. The equipment includes the latest devices in the way of drying stoves, hydraulically operated moulding machines, and sand grinding and mixing machines, much of the latter equipment being electric driven. For mechanical stoker work high-class castings are, of course, essential. The buildings are also served by electric overhead travelling cranes with auxiliary hand cranes to lift mechanical stokers in the erecting shops, and the line shafting is motor driven, the current being 400 volts A.C., and the artificial lighting, electric throughout, is also on the latest lines. A specialised works of this character erected complete on a new site means, of course, not only an enormous reduction in the cost of manufacture, but also increased quality and efficiency in the finished article, and Messrs. The Underfeed Stoker Co., Ltd., are to be congratulated on their undertaking.

GRAPHIC COMPARISON DEVELOPMENT OF UNITED STATES AND EUROPE.*

The best way to measure the relative extent of the development of telephone service in two places is to compare the population of each place with the number of telephones in use in that place. This has been done for the United States and Europe in the accompanying chart, which shows the number of telephones per 100 population from 1877 down to the latest date for which information is available.

The superiority of the telephone development of the United States over that of Europe is clear. In proportion to population, there are ten times as many telephones in the United States as there are in Europe, and Europe to-day has succeeded only in making a



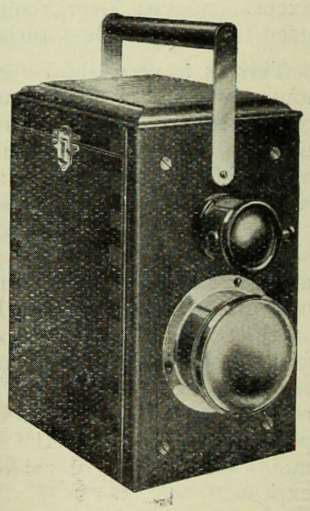
IS COMPETITION RESPONSIBLE FOR THIS DIFFERENCE IN TELEPHONIC DEVELOPMENT?

point which was passed in the United States as early as 1900. In other words, telephonically speaking, Europe is 20 years behind the times.

* *Telephony*, Chicago.

THE "ACM" ACCUMULATOR HAND LAMP.

This accumulator hand lamp, which has recently been placed on the market by the Hart Accumulator Co., Ltd., of Stratford, is specially constructed for general inspection work, and where electric lighting is required in portable form instantly available at the touch of a switch. Its moderate weight, convenient size and ample lighting power readily appeal to all interested in a thoroughly reliable and efficient electric hand lamp. It is fitted with a 4-volt "Hart" accumulator, this being contained in a varnished teak case having a nickel-plated metal carrying handle on top and a powerful "bull's-eye" lens and reflector fitted on the front, with a "push-through" switch mounted above, as shown in illustration. This switch is so arranged that it can readily be operated "on" and "off" by the first finger of the hand in which the lamp is carried, and when required, a steady concentrated beam of brilliant light can be utilised in any required direction.



The accumulator is of sufficient size (9 ampere-hours capacity) to give 20 hours continuous lighting on one charge, and when recharging is required, it is easily removed from the wood case by detaching the two flexible connections inside the case.

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If you have not yet used them try the experiment.



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A Confidential Report that is best made public-

Confidential

April 19th. 1923

REPORT No 26
BIRMINGHAM BRANCH

J.P. Beckett & Co.
134, Victoria St. Grimsby

Mr. Atterby is using our cable exclusively and has a very good opinion of it. He mentioned as an instance of its reliability the wiring of large shop premises of the firm of Guy & Smith, Milliners, Grimsby. Their premises were wired with our Lead covered Cable drawn into conduit about 18 years ago and during some extensions with H.W.S. 2/3 years ago a portion of the old wiring was taken out, and on finding its condition so good some of the lengths were used over again. The remainder was taken away and used for shop wiring for another client who required a cheap wiring job and who agreed to the old cable being used.

The Cable was tested after removal and before re-installing; both tests were quite good and there has not been the slightest trouble since.

Another Henley Cable that is working overtime

HENLEY

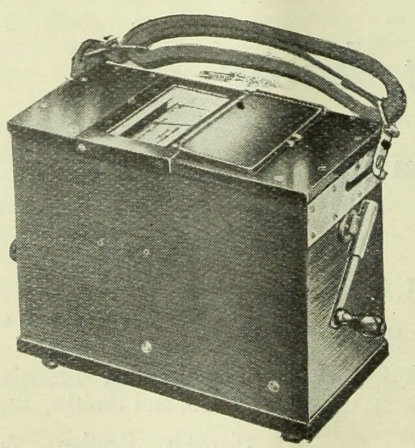
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RECORD

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Weight UNDER 12 lbs.

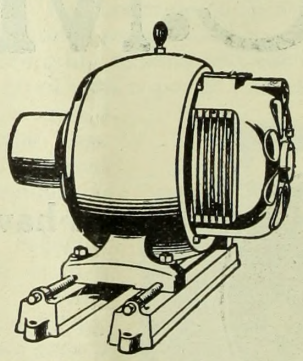
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TO OUR READERS.

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Current Topics.

Overhead Conductors.

It will be interesting to follow the development of the practice of overhead distribution of electricity in this country. For too long have we pandered to the theoretical objections of the minority in regard to the alleged unsightliness of overhead wires and cables, and have paid dearly for the privilege of preserving the so-called amenities of certain districts. In the centre of a busy city or town, overhead conductors are obviously out of place, but when one reaches the outskirts and suburban areas the usual objections no longer hold good, and it has been purely due to convention in the past that we have not followed the practice of other countries and more generally adopted the overhead system of distribution. The fact is the more surprising having regard to the fairly universal acceptance of overhead trolly wires for electric tramways, which must of necessity follow the principal routes of our busiest cities and towns, and are far less adaptable to their environment than ordinary supply cables would be if erected overhead.

When one considers the enormous cost of trenching for cables over a widespread area of distribution, the laying of the conductors and filling in of trenches, making good, etc., to say nothing of the subsequent disturbance of the surface whenever a fault occurs or it becomes necessary to extend the system or throw off branch services, it is obvious that the present cost of electrical energy is largely made up of items which would totally disappear if the system of distribution were above ground instead of below the surface. There is the additional factor to be taken into consideration that a less costly specification of cable is necessary for overhead distribution than would be essential for underground service. Unquestionably the traditional objection to overhead construction in this country has seriously militated against the more rapid development of electricity supply in the past, and, had it not been for the uneconomic necessity of running underground cables, many outlying districts at present lacking facilities would have had them long since with overhead distribution.

In the circumstances it is gratifying to note that Sheffield has already set an excellent example, and work is actually in progress on an overhead cable at Woodbank Crescent. Among the districts which will benefit by this radical departure from precedent are Handsworth, Woodhouse, Abbey Lane and Norton. The all-important subject was ventilated at the recent Convention of the Incorporated Municipal Electrical Association, when the following striking comparative costs were cited as illustrating the saving possible by substituting overhead for underground conductors:—

Voltage.	Underground.	Overhead.
11,000	£2,440	£950
6,600	£1,000	£450
500 and under ...	£846	£430

From these comparative figures it will be noted that the cost of running a mile of cable for ordinary low-tension services overhead is approximately half that of serving the same route underground.

Taking the single example of Sheffield, with an expenditure on mains for one year amounting to no less a sum than £112,000, and assuming a saving of at least one-third if overhead conductors were employed wherever practicable, and it will at once be realised what an enormous total economy would be rendered possible throughout the British Isles once we generally accept the principle and sacrifice our conventional objections. So far as public safety is concerned there is little cause for anxiety, the existing regulations are certainly drastic enough to afford the public every safeguard, whilst the comparative absence of casualties due to falling trolly wires in our busy cities, where they are subject to constant friction and far greater strains than ordinary cables would be, is a measure of the trouble to be anticipated under this head. By all means let us have universal overhead distribution wherever practicable; it will go far towards solving the problem of universal electrical service.

Electroculture.*

Although comparatively little has been heard of late concerning the development of electroculture, or the application of electrical treatment to growing crops, invaluable research work has been continuously carried on, and in due course we shall doubtless profit by the experience now being gained in the process and its method of application. According to the *Journal of the Ministry of Agriculture*, by a series of experiments, spread over a number of years, the Committee have shown the type of electrical apparatus most suitable for the production of the high-tension discharge, and have also shown that an increase of 20 per cent. can be obtained with certain cereal crops. The Committee propose to devote the greater part of their energies in 1924 to pot-culture, small plot experiments, and to laboratory investigations, because they consider this will throw much light on the proper conditions of electrical discharge in the fields.

It is claimed that during 1922 remarkable results were obtained in pot-culture experiments with grain, an increase of 118 per cent. being obtained with a single month's electrification. Field experiments will be resumed in 1925 on the basis of the knowledge now being gained by the smaller scale experiments, and by the end of that year it is confidently anticipated that very definite progress will have been made in the science of electroculture, sufficient, in fact, to justify its practical application on a commercial scale. The

* Interested readers should study *Growing Crops and Plants by Electricity*, by Dudgeon; price, 1s. 8d., post free from this office.

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system now favoured is similar to that originally introduced into this country by Professor Lemström, of Helsingfors, some twenty years ago.

It consists in the overhead discharge of current from a network of conductors stretched over the growing crops and suspended from poles. The Ministry's experimental area at Rothamsted is five acres, and there are nine creosoted poles, each 24 feet long, of which six feet forms the sunk-on butt. The height of the poles above ground is thus eighteen feet. Four of the poles are in the field and five in the hedges. Supporting wires at the ends and in the middle of the area are of rustless steel, and there are twelve thinner conductors of silicium bronze, each 200 yards long. The cost of the installation, including its erection, was £52, or approximately £10 per acre. British agriculture needs a fillip, and we must live in hope that the forthcoming electroculture developments will provide a much needed stimulus.

Third Rail Maintenance.

I travelled recently, for the first time in many months, over a short route on one of our oldest electrified lines, and was particularly struck by the apparent deterioration of the third rail. When I last used this line there was no perceptible variation in the lighting of the coaches, except the usual dimming due to voltage drop at starting, but, on the present occasion, throughout the short journey it was physically impossible to read, due to the incessant flickering of the lights whilst the train was in motion. It was not an isolated case, for I had the same experience on my return journey, and noted on alighting that the third rail was rusty, pitted and considerably worn. It may have been a case of repairs long delayed, but what struck me most was that if the comparatively small current consumed by the train lighting circuits was subject to this serious variation, what must be the effect upon the motors, with their far heavier demand upon the contact surfaces of rail and collector shoe. Incidentally, I should imagine the behaviour of an electrified train's lighting system is a fair indication of the condition of its current-collecting media.

ELEKTRON.

CHICAGO'S NEW MACHINE-SWITCHING AUTOMATIC TELEPHONE EXCHANGE.*

Chicago had its first use of "machine switching" telephone service at midnight, Saturday night, June 9, one manual office having been cutover at that time. The change affected only the subscribers having CENtral numbers, and the rest of Chicago's 654,000 telephones will be operated as heretofore.

All the telephones having CENtral numbers were equipped with dials, and since the cutover, calls from these telephones are made by dialing instead of with the aid of operators.

This cutover involved the transfer of the service of 15,000 telephones and 550 private branch exchange switchboards from the CENtral manual office at 69, West Washington Street, to the machine-switching equipment in the Franklin Building at 311, West Washington Street. At the same time 2,400 trunk lines connecting CENtral with the 75 other offices in the city were transferred.

The machine-switching equipment is of the so-called "panel type," manufactured in Chicago by the Western Electric Co. It is this type of machine-switching equipment that is in use in Omaha, Kansas City, Mo., Philadelphia, Buffalo, Providence, Seattle and New York City.

Another cutover, which is expected to be made later this year, will be 8,500 STAte telephones and 332 P. B. X. switchboards to the new STAte machine-switching unit, which is housed in the Illinois Bell Telephone Co.'s building at 311, West Washington Street.

The introduction of the machine-switching telephones did not cause any operators to lose their jobs. It will be a great many years before all the offices are changed over, and the usual turnover in the operating force will automatically take care of any reduction in force. Even with machine-switching operators will always be required to handle special calls, toll calls, information and similar traffic.

Previous to the cutover the apparatus had been conditioned and made ready for service and then proven by sending several million test calls through it. One hundred and fifty women were employed in sending and receiving these test calls, which were sent to and received from all offices.

There is a special switchboard provided where operators will complete calls to nearby toll points, such as Oak Park and Evanston, and where subscribers, who are unable for any reason to dial numbers for themselves, may receive assistance. Calls for not working or disconnected numbers will also be intercepted at this switchboard.

The system is thoroughly protected with so-called "time measure alarms." In the event of either failure of the apparatus or incomplete dialing or other improper manipulation in the use of the telephone by the subscriber, after a predetermined time interval, alarms are given at suitable locations in the switchrooms, calling attendants to the assistance of subscribers who may be in difficulty. The time measure system is uncanny in its accuracy and almost human in its ability to call attention to matters requiring it.

All CENtral subscribers using the new system were instructed how to use the dial telephones. This was done by sending instructors to visit each subscriber and by actual demonstration, accomplished by having the subscriber's line temporarily connected to the machine-switching office, showing the subscriber just how calls should be made. Subscribers were also encouraged to make practice calls.

Within a few seconds after a subscriber removes the receiver from a telephone he hears the "dial tone," the equivalent of the operator's "Number, please?" which indicates that the apparatus is ready to receive the dialing. The subscriber then dials the first three letters which are capitalised in the directory, of the exchange name followed by the four figures of the telephone number proper.

The dialing is recorded on rotary switches in a complicated device employing many pieces of apparatus called a "sender." Associated with the sender is a "translator," which serves to translate the subscriber's dialing into information which the apparatus can use in selecting an idle trunk line to the office which is being

Telephony (Chicago.)

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called. This selection is made almost immediately after the first three letters have been dialed. As soon as the dialing has been completed, a lamp associated with the selected trunk line lights in front of the operator, who sits before it at its distant end, indicating to her that a call has arrived on the trunk. The operator then depresses a key and the number being called appears in lighted numerals before her, and she then completes the connection in her board to the number indicated.

If the call is for another machine-switching telephone in CENtral office, the equipment is directed to find an idle trunk to the particular group of 500 lines which includes the called number. Within this group the particular hundred, ten and unit identifying the called line is selected and the connecting apparatus, called a "final selector," moves to the line terminal. Before it establishes connection, however, it tests the line to see if it is busy. If it is busy, the busy signal is given to the calling subscriber. If the line is not busy, connection is established and ringing starts.

Calls coming from manual offices are completed by operators who use a key set like an adding machine to set up the number being called.

To call long distance, subscribers dial "211" and the sender then directs the apparatus to find an idle line to the long-distance operator.

In the building at 311, West Washington Street, the machine-switching equipment is located as follows:—

FIRST FLOOR: Main distributing frames where all the underground cables are terminated on lightning arresters.

Power plant.—Three 1,500-ampere direct-connected, charging generators and several smaller machines. These are all used for charging the storage batteries.

Ringing and tone machines.—These machines furnish the various tones required, such as the "dial" and "busy" tones, and provide the current that rings subscribers.

Storage battery.—Two large storage batteries. These furnish the power to run the office at such times as the charging generators are not in operation.

Repair department.—Here are received reports of trouble on subscribers' lines.

Local test desk, eight positions from where trouble on subscribers' lines is identified and located and troublemen are despatched to clear the trouble.

SECOND FLOOR: Entirely devoted to the major apparatus comprising the "STAte" machine-switching office.

THIRD FLOOR: The major apparatus of the "CENtral" machine-switching office is on this floor.

Sender monitors, where all trouble indicated in senders, because of improper dialing, is cared for by men who can establish contact with the subscriber affected and help him to get his party.

"Out" trunk test desk, where all the outgoing trunk lines to other offices appear so that they may be tested periodically.

FIFTH FLOOR: Intercepting positions. Six of these to answer calls for not working or disconnected telephones and to verify reports of "busy," etc., for other operators.

Ten special service positions to complete calls to nearby toll points and to assist subscribers who are, for any reason, unable to dial numbers for themselves.

Cordless "B" position—27 CENtral and 30 STAte to complete incoming calls from manual offices to the respective machine-switching offices.

Questions and Answers by Practical Men.

RULES.

QUESTIONS: *We invite our readers to send us questions, preferably on technical problems that have arisen in actual practice. Questions which we consider of sufficient interest to our readers will either be replied to under "Answers to Correspondents" or replies will be invited from our readers. One shilling will be paid for the question which we select for competitive replies in this column.*

ANSWERS: *A fee of 10s. will be paid for the answer which we consider shows the greatest merit, and 5s. for the one we select as second best. In judging the replies, importance will be attached to clearness and conciseness, as well as accuracy. The Editor reserves the right to make no award, or to accept only one reply, if, in his opinion, the answers received do not possess sufficient merit. Competitors desiring the return of their manuscripts, if unaccepted, should enclose stamped addressed envelope.*

Write on one side of the paper only, and if diagrams are sent, draw them on a separate sheet of paper attached to the manuscript. Competitors may adopt a "nom de plume," but, both in the case of questions and answers, the competitor's real name and address must be sent with the manuscript as a guarantee of good faith. No correspondence will be entered into with regard to successful replies. The Editor's decision is final.

Commencing with Question No. 101, a Diploma of Merit will be awarded to the six competitors who win the first or second prize the most times during the next twelve months.

The words "Questions and Answers" or "Q" and "A" should be placed at the top left-hand corner of all letters intended for this column.

QUESTION NO. 163.

I have a room 32 ft. long and 18 ft. wide. I wish to light it with electric light. I wish to produce about 6-foot candles intensity at the working plane, about 4 ft. from the ground. I would appreciate details of how many points to fit and the candle-power of the lamps.—"CUTTER."

QUESTION NO. 164.

I have an electric iron, but it has gone wrong. I have opened it out, and I find that the element is what appears to be aluminium paint on mica. I also notice that the circuit through this paint is interrupted. Since I cannot purchase a spare element, is there any means of repairing the defective element? If not, how can I convert the iron to use another element?—"LAUNDER."

(Replies to Questions Nos. 163 and 164 must be received not later than July 28, 1923.)

Answers to Questions.

QUESTION NO. 159.

I wish to decrease the speed of a direct current motor under my charge. I desire to do this without the insertion of resistances, which I understand are very wasteful. How can I most efficiently do this? The motor is 40 h.p., 220 volts, compound wound.—"INSPECTOR."

The first prize (10s.) has been awarded to "L. R." for the following reply:—

For the purpose of understanding what methods are available for the efficient speed reduction of an existing electric motor, it is desirable to regard it as a dynamo generating the back E.M.F., which must necessarily be produced on the rotation of any motor. This E.M.F. is substantially identical with the voltage applied to the motor terminals, except for differences due to resistance losses, and may therefore be considered as the supply E.M.F.

The voltage generated by a dynamo depends on the speed of rotation, the number of conductors in the

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armature and the flux through the gap. The equation co-relating these quantities is:—

$$E = nZN \div 10^8.$$

In this equation:

E represents the entire electromotive force generated in the armature expressed in volts;

n is the number of revolutions per second;

Z is the number of conductors on the armature counted all round the periphery;

N is the magnetic flux or the whole number of magnetic lines from one pole.

E, being fixed, namely, the voltage of the motor supply system or the back E.M.F., which, it is understood, is to be generated if the speed n has to be varied, either the number of conductors (Z) must be changed or the flux (N) must be altered. This applies whether the speed is to be increased or decreased. For decreasing the speed the product of Z and N must be increased, and for increasing the speed the product of Z and N must be decreased.

In order to change the value of Z it is clear, therefore, that the armature of the motor must be rewound. This is one way of changing the speed, and it is an efficient way. On the other hand, it entails cost which may be considerable.

Another point to be borne in mind is that, if the motor has been designed to run with a certain characteristic curve in its present condition, it is not likely that the same characteristic will be maintained when the armature has been rewound. The degree in which decrease of speed is required, and therefore the degree in which alterations are to be effected will to some extent determine this; but, if rewinding of the same armature carcass is is to be attempted, one is limited by the number of slots already existing, and it is quite possible that the characteristic curve of the rewound machine will be substantially different from that of the machine as first constructed.

Assume that it is not possible to rewind the armature, one is left with the only alternative of changing the flux, that is, the value of N. From the equation it is clear that if the speed (n) is to be decreased and the value (Z) remains constant, the voltage also being constant, N must be increased in order that the product on the right-hand side shall be equal to the supply voltage.

This is the explanation of the phenomenon that is sometimes not fully understood, namely, that an increased resistance in the field circuit of a motor will increase the speed. The reason is that the increased resistance, by reducing current, reduces the value of N.

In order to decrease the value of n on the assumptions made, it is therefore necessary to wind more wire on the field magnet coils, so that a higher flux can be sent through the poles. Either the shunt windings may be added to or the compound windings depending on the characteristic of the machine required, but there is a limit to what can be done, and that is the limit of saturation of the pole pieces. If the pole pieces are already saturated, no additional windings on the magnet coils will assist. In that case, rewinding of the armature is the only efficient remedy. If the range of speed drop required cannot, for instance, by reason of an approach to saturation of the field magnets, be obtained either by adding turns to the field coils or by rewinding the armature alone, both methods can be adopted, but in that case it is probably cheaper to buy a standard low-speed machine.—"L. R."

The second prize (5s.) has been awarded to "M. M." for the following reply:—

When a motor is running it generates an electromotive force similarly to an ordinary dynamo. In the case of a motor this force, being opposite to the impressed force, is called a back electromotive force.

The motor will run at such a speed that the 220 volts minus the back electromotive force will just leave a sufficient voltage to send such a current through the armature and series winding as will provide the necessary torque for the output. Now, this back electromotive force will vary directly as the field and the speed. Therefore, if a lower speed is wanted the field must be strengthened.

It may be possible to do this by the insertion of liners under the poles, thus reducing the air gap. Sometimes a 10 per cent. reduction in speed may thus be obtained, but so much depends on the mechanical construction of the machine and the degree to which the magnets are saturated that this method may not be practicable.

Another way is to connect the fields in parallel, and by means of a suitable resistance obtain a stronger field. Although in this case a resistance would probably be required, the loss would be much less than if the volts were cut down by means of a resistance in series with the motor. Or, again, an extra winding could be put on the magnets. Both these methods would very likely mean trouble through increased heating of the fields.

An ideal arrangement for speed control is the "Ward-Leonard"; with this combination speed can be varied from zero to maximum with facility. This, however, would no doubt entail too great an expense.

If for a permanency, rewinding the armature might be considered; but, if the reduced speed is only a temporary requirement, a resistance in series with the motor would perhaps meet the case most satisfactorily. Taking average figures, to reduce the speed 20 per cent. with same torque a resistance of approximately .207 ohm will be required, which will mean a loss of 6.2 h.p.

The compound winding has not been considered in the above answer, as no information is given as to the purpose for which the motor has been compounded.—"M. M."

New Books.—Two new wireless books have just been published by Messrs. Cassell. They are *Simple Crystal Receiving Sets and How to Make Them* and *Simple Valve Receiving Sets and How to Make Them*, both by B. E. Jones. Reviews will appear in due course; meanwhile copies may be ordered at 1s. 9d. each net post free from ELECTRICITY Office.

Staff Outing.—The fifth annual outing of the staff of the "D.P." Battery Co. took place on Saturday, July 7, when they were favoured with a beautiful day. The party, which numbered 47, went by road through some of the most picturesque parts of the district to the Derwent Valley, whence, after a picnic tea at the Snake Inn, the well-known house of call in the heart of the Peak District, the road was taken through Hope and Castleton, where a fine view is obtained of the remains of the Castle of the Peveril of the Peak, which subject was used for the firm's calendar last year. The performance of "When Knights Were Bold" at the Opera House, Buxton, concluded a most enjoyable day.

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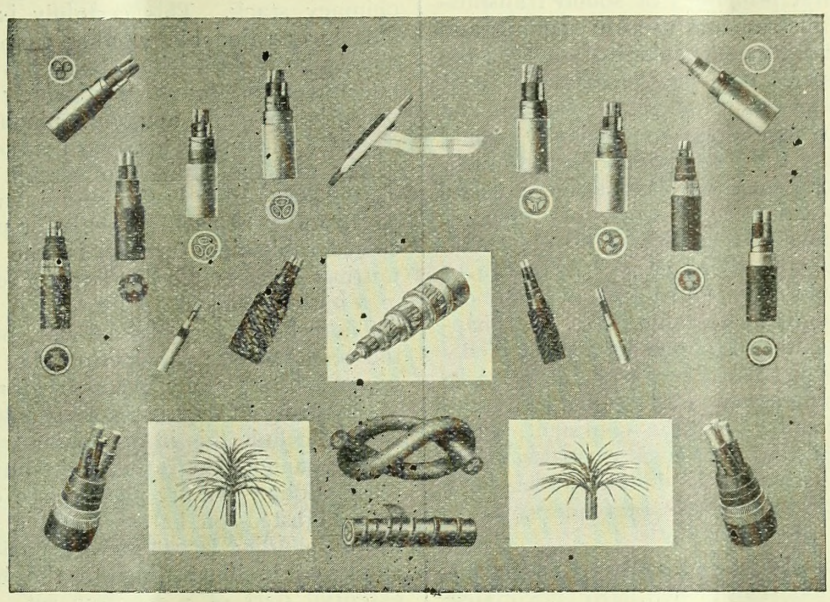
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Reviews of Books, &c.

[*Books noticed in this column will be sent from* ELECTRICITY *Office to any part of the world, for the published price, plus ten per cent. for postage (minimum 2d.), and orders will be appreciated.*]

TELEPHONY. By McMeen and Miller. Revised edition, 8vo, leather, 950 pp., 682 illustrations. (Chicago, American Technical Society, 28s. net.)—This book has been a classic for telephone engineers for many years and is known as such in practically every country in the world. It went out of print during the war and the demand for a new edition could not be met for several years, but it is now with us again, and in its revised state will be most cordially welcomed. As a book of instruction for students it is wonderfully comprehensive, covering the ground completely from the first principles of sound transmission and the types of instruments used in sending and receiving, to the elaborate mechanism of one of the leading automatic systems now on the market. It is a pity that other systems are not given, but we can only presume that to have done so efficiently would have involved increasing the size of the book too much. To the actual telephone engineer it will be a useful asset because of its value as a work of reference in regard to almost any point on which he may wish to refresh his memory, and there is such a wealth of diagrams that it should help to smooth over almost any difficulty which might be encountered. The chapter on the transcontinental telephone line is decidedly interesting at the present time, when Mr. Gill is working so hard on the extension of long distance telephony between this country and the continent, while cables and underground and overhead construction are dealt with most exhaustively. Undoubtedly this new edition will have a very wide circle of readers.

ELECTRICITY SUPPLY ACCOUNTS. By G. Johnson, F.R.S.A. Third edition, cloth, 8vo, 181 pp. (Gee, 10s. 6d. net.)—Mr. Johnson's book has already established a reputation as a work of direct interest and, indeed, use for all secretaries and accountants of electricity undertakings incorporated as limited companies. In this new edition an important introductory chapter has been added, dealing generally with the main principles of the 1919 Electricity (Supply) Bill and the influence which it will bear upon the future conduct of the industry. It should therefore be studied carefully by all who are associated with the financial side of electricity production.

A BEGINNER IN WIRELESS. By E. Alexander. (Dranes, 3s. 6d. net.)—Yet another book for the beginner covering the same old ground, in more or less the same way as many other scores of books on the subject, and, apart from the fact that it does fulfil its object of leading the beginner through the early history and theory of wireless, it does not contain anything that would specially recommend it to anyone who has already covered the same ground. We have several times before made a statement to the effect that in reading any wireless book through, however simple, there are points brought home forcibly, which perhaps one has not realised to the full in reading through previous articles on the same subject, and there are several points in this book that stand out to prove this rule. At the same time, there are other statements made which it is rather difficult to believe are intended to be final, and the author himself would no doubt agree that in wireless more particularly "circumstances alter cases."

As instances of the one or two first-mentioned points, the reader is advised to examine the down-lead at a point where it is fastened to the switch. In this case, we assume the switch is fitted outside the building, or if not to the switch, to the outside end of the lead-in insulator. If the down-lead swings, crystallisation of the metal is almost bound to take place at this point, and breakage result.

Another instance is the remark that in attaching an aerial to a chimney stack, the fixing should never be higher than one-third of the total height of the chimney stack. This certainly is very sound advice.

It is questionable whether chapters on transmission should be included in a book having the scope of the one under discussion, particularly when there are apparently so many amateurs playing with transmitting circuits, when they have no licence or authorisation so to do, and the addition of circuit diagrams in a book of this sort rather leads the uninstructed to attempt the construction of such a circuit for pure experiment, and considerable interference is the result. The transmitting side should be left for description in works of a more technical nature.

These latter remarks are not, of course, peculiar to the book we are considering, but the details that are given are not really necessary for the general outline of the theory of transmission, should it be deemed essential to include this in a popular treatise.

One cannot congratulate the author on many of his illustrations. An art paper page devoted to a picture of a high-tension battery, and a further one devoted to an alkaline accumulator, could better have been employed in illustrating to the beginner some more essential part of a wireless set. As a beginner and an amateur, he buys the H.T. battery stocked by his local wireless store, and it is extremely doubtful whether he would ever purchase an alkaline accumulator, more especially as the illustration shows one of a traction type. We are afraid that he would have a little trouble in getting such a battery satisfactorily attended to at local charging stations, the personnel of which may not be very well acquainted with a battery of this type, to say nothing of the disadvantages due to low ampere hour efficiency.

The illustrations of high-power transmitting sets are also not of much interest to the person for whom the book is intended.

To summarise the book, to the person who has read nothing of the kind before it is good, interesting and accurate, but to those who have made even a small study of the subject, it does not offer any additional information of value.

The I.E.E.—The result of the voting for the election of new members of Council, etc., was as follows:—President, Dr. A. Russell, M.A., D.Sc.; Vice-President, Sir James Devonshire, K.B.E.; Hon. Treasurer, Mr. P. D. Tuckett. Ordinary members of Council:—Members, Messrs. J. M. Donaldson, W. M. Thornton, D.Sc., Colonel T. F. Purves, Messrs G. W Partridge and P. Rosling; associate member, Mr. S. W. Melsom.

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SOME NOTES ON PHASE ADVANCERS.

In these days, when the importance of a high power factor on a supply system is more fully recognised, as is shown by the frequency with which, either directly or indirectly, the problem is dealt with in the technical Press, a few notes on the general principles underlying the "phase advancer" may not be out of place.

The primary cause of the inherently low power factor of the induction motor is its air gap. Even when this is reduced to the minimum, consistent with mechanical safety, its comparatively high reluctance causes the magnetising current of the machine to be a considerable percentage of full load current. Since this current lags behind the impressed voltage by almost 90 deg., the power factor of the induction motor can never become unity: and, since its magnitude is almost independent of the load, it follows that at light loads the power factor is very poor indeed.

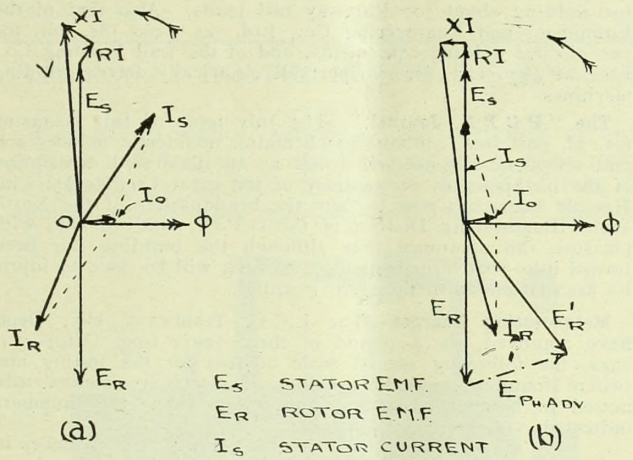


Fig. 1.

From Fig. 1 (*a*) it will be seen that the magnetising or no-load current is the vector difference between the rotor current and the stator current (strictly speaking, we should substitute ampere turns for current, but the latter is true if we assume that the number of turns in stator and rotor are the same). It follows, therefore, that if the vector difference is fixed both in magnitude and phase, a displacement of the rotor current vector will, of necessity, produce a displacement of the stator current vector. If by some means or other we could advance the phase of the rotor current, that of the stator current would also have to advance, and would come more nearly into phase with the impressed voltage.

One way of doing this is to produce in the rotor circuit an E.M.F. leading the rotor current by 90 deg. At or near synchronous speed the reactance of the rotor is small, and thus the rotor current does not lag far behind the rotor E.M.F. The injected E.M.F. referred to above would therefore lead the rotor E.M.F. by almost 90 deg. The resultant E.M.F. would thereby be advanced, as is shown in Fig. 1 (*b*), and, since the angle of lag between rotor current and E.M.F. is fixed for any particular speed by the constants of the rotor circuit, the former would, so to speak, be dragged after it and advanced in phase also. Since, however, the no-load current is fixed both in magnitude and phase, the stator current will also have to advance in phase, and thus the power factor of the machine is improved.

Broadly speaking, therefore, the object of a phase advancer is to inject into the rotor circuit an E.M.F. which shall be in leading quadrature with the rotor current.

The two main types of advancer are the Scherbius rotating and the Kapp vibrating type, of which the former will be dealt with first.

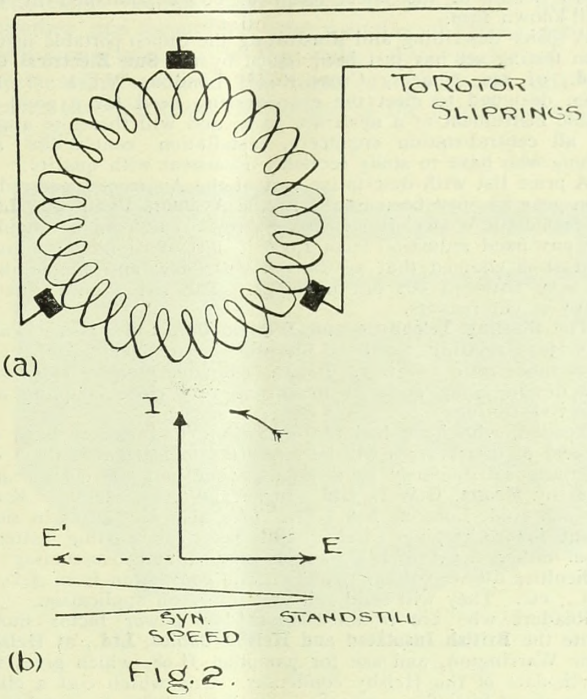


Fig. 2.

Suppose we take an armature with an ordinary D.C. winding and fit three brushes, equidistantly spaced, round the commutator, as shown in Fig. 1 (*a*). If the armature is stationary and fed with three-phase alternating current through the brushes, it will behave as a three-phase choking coil, and will produce a field rotating relatively to the armature. Now, since the feeding points (i.e., the brushes) are fixed in space, the rotation of the field relative to them will not be affected by any movement of the armature. When the armature is stationary, the field, cutting the conductors, creates an inductance E.M.F. which, neglecting the resistance of the circuit, lags 90 deg. behind the current. In this connection it must be remembered that, when we speak of a choking coil taking a lagging current, it is referred to the impressed voltage, and, since the actual inductance E.M.F. is in phase opposition to this, it must lag 90 deg. behind the current, i.e., the current lags 90 deg. behind the impressed voltage, but the inductance E.M.F. lags 90 deg. behind the current.

Now, suppose that the armature is revolved by some external means in the *same* direction as the rotation of the field. Obviously the rate at which the flux cuts the conductor will decrease, and the apparent inductance of the armature will diminish; until if the armature be accelerated until it revolves at the same speed as the

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field, it will behave as if it possessed no inductance at all, but only ohmic resistance. If the speed be now increased still further, the conductors will be cut by the flux in the opposite direction, the armature will appear to possess "negative inductance," or capacity, and the E.M.F. induced will *lead* the current by 90 degs. (See Fig. 2 (*b*)).

(*To be continued.*)

Trade Notes.

Readers should make a point of writing at once to **Chapman and Hall, Ltd.**, W.C.2, for a copy of their list Y 3, which gives details of the latest technical books published by this well-known firm.

A folder describing and illustrating the Sunco portable insulation testing set has just been issued by the **Sun Electrical Co., Ltd.**, of 120, Charing Cross Road, London, W.C.2. It has been designed to meet the ever-pressing need for a good reliable instrument at a moderate price, and will therefore appeal to all central-station engineers, installation contractors and others who have to study economy consistent with quality.

A price list with descriptive text of the Avamore speed-reduction gear has just been issued by the **Avamore Pump Co., Ltd.**, of Sicklemill Works, Haslemere, Surrey. They can be supplied for any fixed reduction from 1,000 to 1 revolutions per minute, and it is claimed that as the parts are few and simple there is very little to get out of order. The list should interest many of our readers.

The **Sterling Telephone and Electric Co., Ltd.**, issue Leaflet No. 362, relating to their Sterling variometer, having an inductance ratio of 9 to 1. It is a well-made piece of apparatus, the design being such as to ensure very close coupling and selective tuning.

Readers who have had the misfortune to break or burn out several of their valves will be interested to learn that these can be quite satisfactorily repaired at about half the cost of new ones by **Messrs. G.W.I., Ltd.**, Imperial Works, Shanklin Road, Crouch End, London, N.8. This firm also specialises in small plant for recharging wireless and motor-car starting batteries from either A.C. or D.C. supply mains, and overcoming the difficulties due to voltage reduction and conversion from A.C. to D.C., etc. They will send full particulars on application.

Readers who are troubled about low power factor should write the **British Insulated and Helsby Cables, Ltd.**, at Helsby, near Warrington, and ask for pamphlet H 98, which gives full particulars of the Helsby condenser. One which cost a client £323 saved him £42 a month, so he had nothing to grumble at.

Messrs. Siemens Bros. and Co., Ltd., issue an up-to-date list of public and private automatic exchanges equipped on their system, which will be of interest to telephone engineers and others.

From **Messrs. Rogers, Foster and Howell** comes a leaflet descriptive of their R.F.H. reaction sets embodying several noteworthy testimonials regarding these sets and the ranges over which successful reception has been accomplished. In view of the vague information circulated by many manufacturers of wireless broadcast receiving sets regarding the possibilities of their apparatus, this firm are to be congratulated upon the very exact information issued concerning the effective ranges of their various sets, and which will be of close interest to the wireless amateur.

A list giving illustrations and prices of moving iron measuring instruments, dead-beat moving coil instruments, and pocket and miniature switchboard instruments has just been issued by **Messrs. Oswald Record and Co.**, of 17, Victoria Street, London, S.W.1. A separate circular describes and illustrates the "Osrecco" pocket Wheatstone bridge, as well as the "Osrecco" combined insulation testing set and portable voltmeter Both lists will interest electrical engineers generally.

Circulars dealing with "Isolit" insulators, "Zed" fuses and "Vanwyck" overload switches have been issued by **Mr. Frederic Pratt**, of 66, Victoria Street, London, S.W.1, and should be applied for by trade readers who are interested therein.

A list of attractive specialities and novelties has just been issued by **Messrs. Victor Ashby and Son, Ltd.**, of Pioneer Works, Towcester, and will appeal to all dealers in electrical goods. It includes various types of "Sunglow" electric pipe lighters and the "Hotspring" electric shaving-water heater, for both of which there should be a ready sale. The list should be written for.

Various Items.

Ebonite.—Wireless readers will be interested in the bargain parcels which are being offered by an advertiser in the prepaid wireless page.

An Educational Gift.—The L.C.C. Tramways Dept. have offered as a gift to the authorities of the Northampton Polytechnic Institute a tramcar motor armature, which has been lent to the Institute since April, 1921, for use in the class on power armatures.

Personal.—Mr. Victor Delebecque informs us that the agreement between the Electrical Apparatus Co., Ltd., and himself has been mutually terminated, and that all correspondence in future should be addressed to him personally at Cedar Court No. 1, 18, Cedars Road, Clapham, S.W.4.——Mr. J. E. Edgecombe, M.I.M.E., M.I.E.E., formerly borough electrical engineer, Kingston-on-Thames, who lately resigned the appointment of Director of the Electric Lamp Manufacturers' Association, Great Britain, Ltd., has joined the board of the Stearn Electric Lamp Co., Ltd., of 12, Grosvenor Gardens, S.W. 1.

Tenders Accepted.—The L.C.C. Tramways Dept have accepted the tender of the Rail Welding Co., Ltd., at £437 10s., for welding about 700 tramway rail joints. Also that of the Equipment and Engineering Co., Ltd., at £560 18s. 4d., for two electric welding equipments, and of the Rail Welding Co., Ltd., at £576 12s., for two portable electrically driven grinding machines.

The "P.O.E.E. Journal."—The July issue of this magazine (2s. 3d. post free) contains much matter of interest to telegraph and telephone engineers, as well as an illustrated description of the birthplace at Shrewsbury of the great Charles Darwin. His old home has now become the headquarters of the North Wales Engineering District of the G.P.O., and we note with pleasure the assurance that although the building has been turned into a Government office, nothing will be done to injure its associations with the great scientist.

Meter-testing Charges.—The L.C.C. Tramways, etc., Dept. have approved, for a period of three years from October 1, 1922, the following special scale of fees for the testing and (where found correct) the sealing of electricity meters submitted in batches containing not fewer than the numbers indicated, viz.:—

Size of meter.	Fee. s. d.	Number in batch.
Up to 10 amperes	2 6 each	100
Over 10 and up to 50 amperes ...	3 0 ,,	20
Over 50 and up to 100 amperes ...	4 0 ,,	10
Over 100 and up to 150 amperes ...	5 0 ,,	10

The Dept. have also drawn the attention of the Electricity Commissioners to the fact that in Clause 7 of the general conditions relating to the supply of electricity by the Stepney Metro. Boro. Cncl., as set out on the form of application issued to intending consumers, the basis of error in disputed electricity meters is stated to be 5 per cent. instead of 2½ per cent., as allowed under the regulation made by the Council and approved by the Board of Trade, and have asked the Commissioners to take steps to secure the observance by the borough council of the regulation.

CENTRAL STATION VOLTAGES AND CHARGES

IN THE U.K.

A useful set of tables, giving the name of the town or district, ownership, chief engineer, voltage of supply, periodicity (if A.C.) and price charged per unit for lighting, power, heating, etc. and for electric vehicle charging.

48 pp., 1s. 2d. post free.

S. RENTELL & CO., Ltd., 36, Maiden Lane, London, W.C.2

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A POPULAR SCIENTIFIC WEEKLY JOURNAL
ELECTRICITY
A PRACTICAL TRADE JOURNAL

JULY 27, 1923.

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INTERNALLY HEATED ELECTRIC FURNACES.

Consistent results, simplicity and certainty of heat control and hygienic considerations have done much to popularise electric furnaces. Manufacturers in numerous industries realised these important features

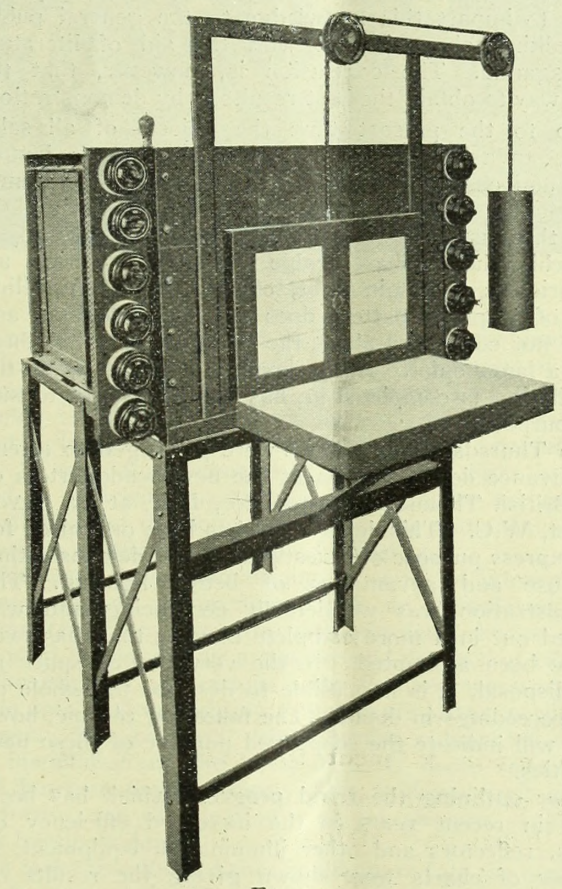


FIG. 1.

and have continually demanded furnaces of considerably larger dimensions than previously constructed. Messrs. Automatic and Electric Furnaces, Ltd., turned their attention to the design of these larger types some time back, but found numerous technical difficulties to overcome. However, they are now in a position to state that these obstacles have all been successfully surmounted, and consequently the new type of Wild-Barfield internally heated furnace is the result.

These new furnaces, of which a general illustration is given in Fig. 1, are built on the unit principle with inside or exposed heating coils, designed to permit the construction of electric furnaces of unlimited size. Each unit consists of a brick, measuring 4 in. by 4 in., specially shaped so as to dovetail into its neighbours. In the face of each unit or brick are three annular channels. When the bricks forming the heating chamber are assembled, the annular channels present continuous grooves in the walls, floor and roof, and the heating units in the form of spirals or rods are drawn through from end to end of the heating chamber or tunnel.

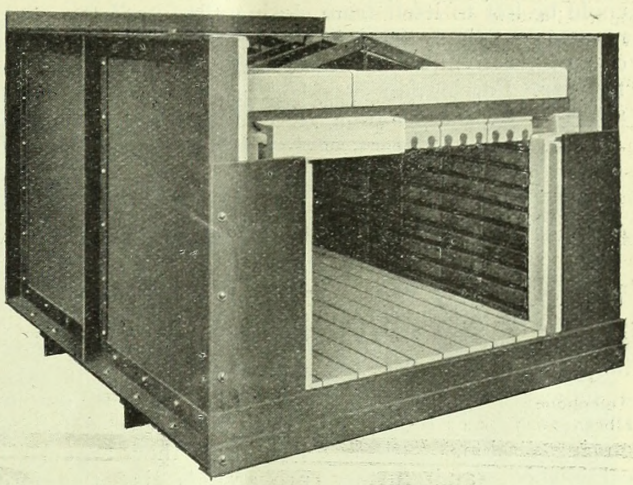


FIG. 2.

Reference to Fig. 2 shows the construction more plainly. It will be noticed that the grooves in which the exposed heating elements lay are shaped so that the spirals, whilst free to expand in all directions, cannot come into contact with the work in the furnace. Special attention has been paid to the roof of these furnaces. The fire-brick units are each recessed to hang from trussed girders of specially treated iron or nickel chrome, and supporting pieces of nickel chrome with "pick-ups" of similar material.

The furnaces are complete with the company's patent automatic cut-out and a thermo-couple, both entering through tubes at the rear.

The heat resisting lagging is of a special nature, and reduces heat losses to a minimum. The outside casing is constructed of boiler plate, strengthened by angle iron to which it is bolted. The door consists of fire-bricks and is usually counter-balanced to facilitate opening and closing. A temperature of 800 deg. C. can be reached in one hour and 1,000 deg. C. in about 1½ hours from cold.

As an indication of power consumption it may be stated that a furnace working up to 1,000 deg. C. measuring 20 ft. by 12ft. by 12 ft., requires approximately 1,400 kw. A carburising furnace of the same construction measuring 24 in. by 12 in. by 12 in. is heated in one hour to 900 deg. C., with a consumption of 11 kw., and the furnaces after the first hour, together

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with work being carburised, is maintained at 900 deg. C. with a consumption of 5.6 kw. The output of these furnaces is practically the same as those of similar sizes heated by gas and solid fuel.

They will be of considerable use for the heat treatment of locomotive cranks, connecting and coupling rods, billets, plates, carburising, etc., and in annealing both ferrous and non-ferrous sheet, wire, etc., also for baking and kilning pottery ware. In fact, it may be stated that they are designed to replace existing gas and solid fuel furnaces of all sizes.

It is hoped that electric supply authorities will appreciate industrial heating loads of this description, meaning many kilowatts at unity power factor and, further, a load that is practically continuous for nine hours a day for five and six days every week in the year. They are also admirably suited for supply authorities who desire night loads for carburising steel parts in large or small engineering works. In conjunction with a time switch the work and furnace could be left to itself from closing time until the works reopen next day. The makers will be pleased to show one of these furnaces in operation at their works at 173-175, Farringdon Road, London, E.C.1, and to supply fuller information if required.

LIGHTING.

A New View-Point—A New Programme and a New Campaign.

Electrical men, especially those associated with the generation of power and the technical branches of the industry, regard the installation of electric light as a subject of minor importance. They are of opinion that no skill is required in designing or maintaining an installation. "Electric lighting," they argue, "is established, and further propaganda is, therefore, superfluous.

"Electric lighting is the best kind of lighting obtainable, and, as such, needs no recommendation, and admits no improvement. Let us, therefore, concentrate our propagandist efforts upon the popularisation of electric heating, cooking, ventilation and power, etc."

It would be very difficult to say how, or why, these impressions were created, since it does not require a great amount of consideration to realise that electric lighting may be truly said to be the bedrock upon which the whole electrical industry has been built. Without electric lighting all other branches of the industry would not be possible from an economical point of view. It has not been realised that, if the lighting load on a power system were eliminated, the demand for plant, cables and practically every electrical accessory manufactured to-day would cease, because the excessive cost of the supply of current for other purposes would prohibit their use.

Let us consider, however, the effect upon the electrical business generally if the lighting load could be increased by ten or twenty per cent. Our generating and manufacturing resources would have to be enormously increased to meet the demand for current and apparatus. The lighting load *can* be considerably increased—not at once, but in a reasonable space of time.

The lighting branch of the electrical industry is one of the very few commercial institutions of the world which does not have an opportunity to show its goods. Let us consider, for instance, exactly what happens when we purchase almost any article for everyday use. We consider first its usefulness, then its suitability to meet our requirements in other directions. Assuming that we desire to purchase a hat, we go to a hat shop and, looking at ourselves in the glass, we purchase a hat which is not only useful, but which produces a finished effect upon our appearance. Making comparisons, let us assume that we wish to instal electric light. We go to an electrical contractor and purchase fittings, cables, lamps and current, but the result is a matter of chance. The hatter, in addition to selling us a hat, has provided us with the finished effect the hat produces. The effect produced by the electric light fittings we have purchased is an unknown quantity until the current is switched on. The results may, or may not, meet our requirements, and we find from experience they do not.

The need for better lighting conditions has been realised by illuminating engineers for many years. They understand that the best results cannot be obtained from the rule of thumb methods by which lighting has been sold. Careful consideration of the subject points to the fact that there is a positive need and demand for light of a much higher intensity than is generally used to-day. They have, for many years, tried to impart this knowledge to the general public by talking about it and with the aid of literature propaganda. The conclusion is, however, that the only way to obtain the best results is by demonstration.

Up to the present time the objects of all sales propaganda has been to sell fittings, reflectors, lamps, wire and current. There has been very little attempt to sell the finished product—light. Yet it is light that the customer is most interested in. The object for which he purchases cable and other electrical accessories is to obtain light, efficient light. A ceiling rose of a special pattern does not appeal to him, and he is not concerned about the quantity of metal there is in a lampholder. All he hopes for is that when the installation is completed he has sufficient light to suit his purpose.

On Thursday, July 19, we were privileged to attend an advance demonstration at the new headquarters of the British Thomson-Houston Co., Ltd., at 15, Savoy Street, W.C. This department has been organised for the express purpose of investigating and demonstrating the use and advantages of better lighting. The demonstration was wonderfully convincing, and was carried out in a more complete manner than has ever before been attempted. In the very limited space at our disposal, it is impossible to describe the whole of the proceedings in detail. The following résumé, however, will indicate the scope and purpose of these new activities.

After outlining the rapid progress which has been made in recent years in the increased efficiency of lamps, reflectors and other illumination equipment, a number of charts were shown giving the results of investigations carried out by physicists, etc., indicating that vision in all its aspects is considerably assisted by high intensity lighting. Figures were then given showing the effect of lighting on the speed and

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accuracy of vision and sustained vision. In all cases the curve produced was entirely out of proportion to the increased illumination.

An interesting experiment to demonstrate these facts was made. The apparatus used consisted of a box in which a table, revolved at constant speed by a clockwork motor, was placed. On this table a cardboard cylinder was fixed so that it would rotate with the table. A number of letters were printed upon the cylinder, so that they could be followed with the eye as the cylinder rotated. Lamps of various candle-powers were then switched on at intervals, and this produced the effect that the speed of the cylinder was decreased as the illumination was increased. This proved that the eye could see much more quickly under high intensities, from the fact that it could more easily appreciate movements.

Following this demonstration, the results of tests carried out at a number of different industrial installations were given. It was shown that production was

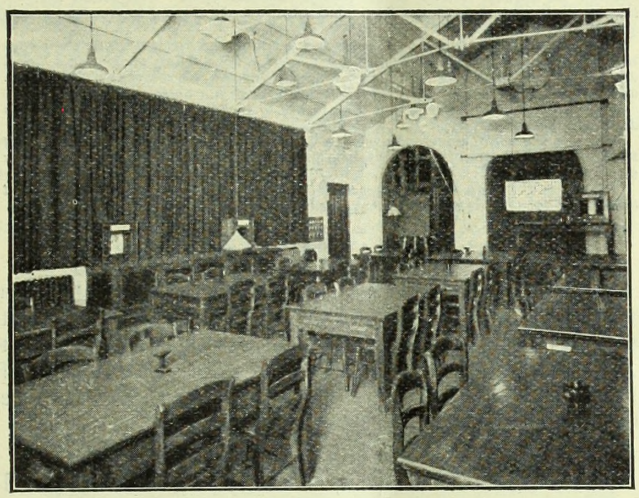


FIG. 1.—INDUSTRIAL DEMONSTRATION ROOM.

increased between 10 and 25 per cent. where modern high intensity lighting has superseded lighting of the average standard. It was also shown that a large number of accidents occurred annually through insufficient lighting in stores and workshops. From this it will be seen that, when it is stated that light is not used in sufficient quantities, and that there are great possibilities of developing business, the statements are based on a solid and scientific foundation.

We were then taken through a series of interesting demonstrations commencing with an installation of antiquated cord pendants with obsolete shades and assorted lamps, giving a gloomy and depressing effect. Following this, the various steps that are necessary to build up a modern lighting system were shown in all its stages. The industrial demonstration culminated with an installation of the latest R.L.M. dome reflectors and bowl enamelled lamps. The combined unit gave perfectly even illumination with an absence of glare and harsh shadows.

In order that the audience could appreciate the quantitative value of the illumination, each member was provided at his table with a foot-candle meter, a handy little instrument that gives direct readings, and it was interesting to note the facility with which the instrument was handled. In addition to giving an actual demonstration of the increased illumination obtainable with better equipment, the experiment also had the great advantage of proving that such measurements can easily be carried out by persons who have no experience, and that light, in foot-candles, can be measured quite as easily as temperature is with a thermometer. The majority of those present appreciated, for the first time, the difference between various intensities of illumination, and perhaps also realised the business and other advantages which would accrue from a universal increase in illumination values.

Apart from the industrial demonstrations, general methods of improving domestic and commercial lighting were also indicated. Later, other phases of illumination, such as street and sign lighting, will be dealt with. Special apparatus is being installed for this purpose.

It should here be emphasised that although certain equipment has been, and will be, employed during

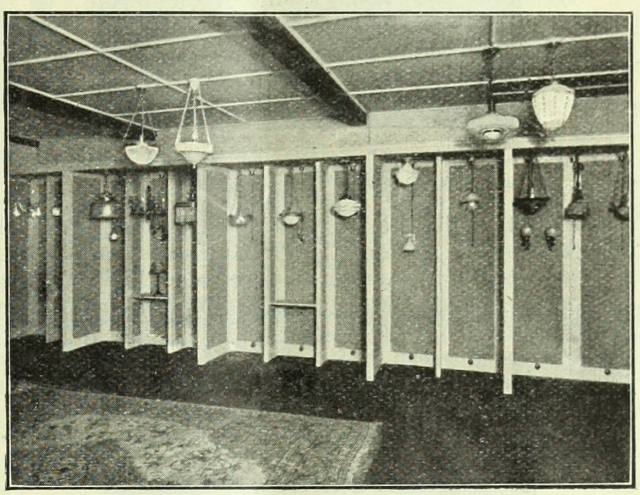


FIG. 2.—DOMESTIC DEMONSTRATION ROOM.

demonstrations, the latter are not being carried out for the purpose of selling particular appliances, but merely with a view to showing, in a general way, the advantages of better lighting and the general means whereby such results can be attained.

A number of interesting and amusing cabinets were arranged around the room showing lighting effects such as, for example, the effect of light on the apparent solidity of objects, the effect of light on the colour of objects, the effect of glare upon the eye, etc.

At the conclusion of the meeting it was realised by all present that if the intensities of lighting throughout the country could be increased business in all directions, from the manufacture of generating plant and control apparatus to the supply of current and the installation of lighting equipment, would be obviously stimulated. Of all, the one who would benefit the most would be the consumer. As a human being he would benefit from more comfortable vision, the business man would benefit from increased profits, and the householder would have a much more comfortable and charming home.

It should be understood that the Lighting Service Department of the B. T.-H. Co., Ltd., has not been merely set up as a temporary inspiration to the trade or as an organisation for demonstrating effects. It is

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a permanent institution which will be constantly engaged in the investigation of lighting in all its aspects and applications. The general public will receive the benefit of the investigations carried out from time to time. The information will be conveyed to them through the medium of handbooks which will be written and distributed among the sections of the industries concerned with the specific subject dealt with.



FIG. 3.—ILLUSTRATING THAT SHADE IS AS NECESSARY AS LIGHT TO GIVE OBJECTS EXPRESSION.

The first of these books has already been published. It is known as "Factory Lighting Designs." It deals, as the name applies, with designs of electric lighting for factories and workshops. From this book, given the quantity of illumination required for any industrial purpose and the size and height of the shop, a design can be obtained to meet all requirement. Each design is illustrated to show the spacing of the units and the candle-power of the lamps used in the units, and the

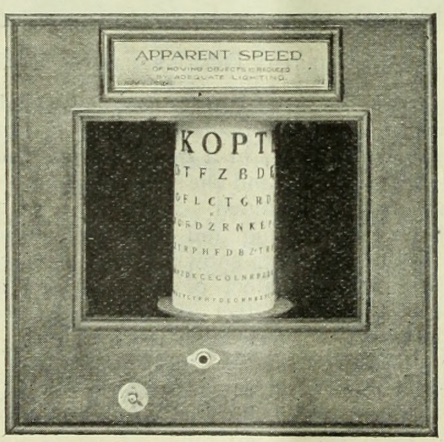


FIG. 4.—ILLUSTRATES THAT THE APPARENT SPEED OF MOVING OBJECTS IS REDUCED BY ADEQUATE LIGHTING.

resultant quantity of the available foot-candles on the work is given in tabular form. This booklet entirely eliminates all tedious calculations, and it can be understood quite as easily by the consumer as the electrical contractor. A table at the end of the booklet gives the amount of illumination necessary for almost any industry.

Of course the department will prove of little value unless the trade generally will co-operate in the work which it is trying to carry out. Mr. W. E. Bush, who is at the head of the department, and his assistants will be pleased to co-operate with all who are interested in this new movement for better lighting. If the movement is to be successful it is necessary that it should have the assistance and co-operation of supply companies, contractors and manufacturers of lighting equipment. They can be of assistance to the Lighting Service Department by telling the story of its activities. The department can be of service to them by providing them with the results of those activities.

Questions and Answers by Practical Men.

RULES.

QUESTIONS: *We invite our readers to send us questions, preferably on technical problems that have arisen in actual practice. Questions which we consider of sufficient interest to our readers will either be replied to under "Answers to Correspondents" or replies will be invited from our readers. One shilling will be paid for the question which we select for competitive replies in this column.*

ANSWERS: *A fee of 10s. will be paid for the answer which we consider shows the greatest merit, and 5s. for the one we select as second best. In judging the replies, importance will be attached to clearness and conciseness, as well as accuracy. The Editor reserves the right to make no award, or to accept only one reply, if, in his opinion, the answers received do not possess sufficient merit. Competitors desiring the return of their manuscripts, if unaccepted, should enclose stamped addressed envelope.*

Write on one side of the paper only, and if diagrams are sent, draw them on a separate sheet of paper attached to the manuscript. Competitors may adopt a "nom de plume," but, both in the case of questions and answers, the competitor's real name and address must be sent with the manuscript as a guarantee of good faith. No correspondence will be entered into with regard to successful replies. The Editor's decision is final.

Commencing with Question No. 101, a Diploma of Merit will be awarded to the six competitors who win the first or second prize the most times during the next twelve months.

The words "Questions and Answers" or "Q" and "A" should be placed at the top left-hand corner of all letters intended for this column.

QUESTION NO. 163.

I have a room 32 ft. long and 18 ft. wide. I wish to light it with electric light. I wish to produce about 6-foot candles intensity at the working plane, about 4 ft. from the ground. I would appreciate details of how many points to fit and the candle-power of the lamps.—"CUTTER."

QUESTION NO. 164.

I have an electric iron, but it has gone wrong. I have opened it out, and I find that the element is what appears to be aluminium paint on mica. I also notice that the circuit through this paint is interrupted. Since I cannot purchase a spare element, is there any means of repairing the defective element? If not, how can I convert the iron to use another element?—"LAUNDER."

(*Replies to Questions Nos. 163 and 164 must be received not later than July 28, 1923.*)

G.E.C. Floodlights.—A steady development has been taking place for some time past in connection with the illumination of advertisement hoardings so that they have an even greater publicity value at night than by day, and the usual method of achieving this effect is by means of electric lamps in reflectors attached to brackets at the top of the hoarding. A very successful example of this method is a large painted advertisement of the Osram lamp maintained by the Borough Billposting Co., at Chiswick. The approximate height of this hoarding is 28 ft. and the length 40 ft., and it is noteworthy that the illumination is carried out by three units only, each containing one 500 watt Osram gasfilled lamp. These units have been specially designed for hoarding lighting by the General Electric Co., and are known as the "Wembley" Reflector Fitting. In the case under review the three reflectors are mounted on brackets projecting only 3 ft. 6 in. from the hoarding. The great difficulty of illuminating a depth of 28 ft. has been overcome by the special design of the reflector, which, in addition to giving a great depth of illumination, provides a wide lateral spread, so that the spacing of the reflectors can be as great as 15 ft. An extremely even illumination distributed over the whole of the surface is obtained with a current consumption of only 1.34 watt per square foot.

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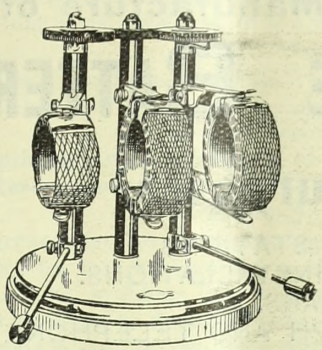
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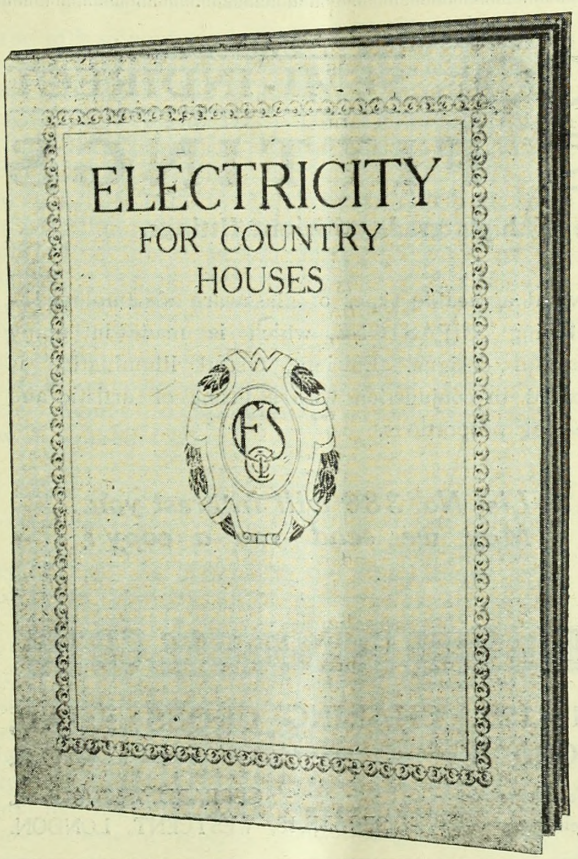
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(Patent applied for).

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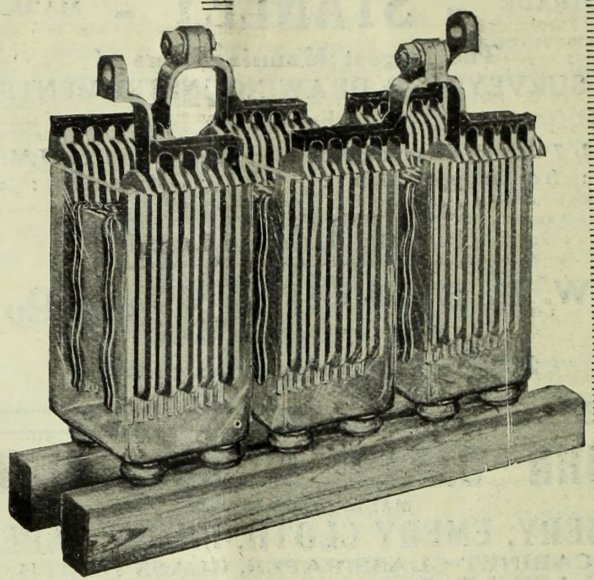
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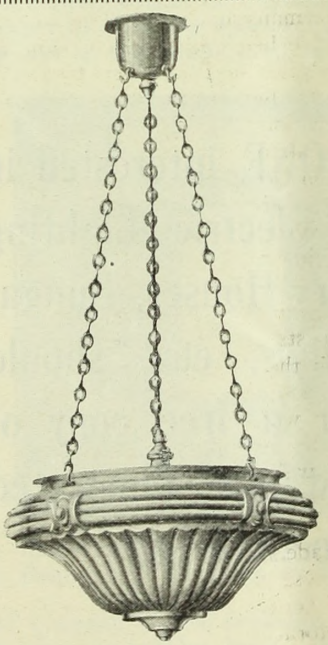
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TO OUR READERS.

ELECTRICITY is published every Friday, and, if ordered, is on sale at the principal Railway Station Bookstalls and Newsagents on that day. It has a very large sale throughout the United Kingdom, as well as in the British Colonies and Abroad.

New advertisements for the displayed columns and alterations to existing ones must reach the publishing office not later than first post Tuesday morning, in order to be in time for the issue of the following Friday. This is important. Rate quoted on application. Subscription: 13s. a year, 6s. 6d. half year, 3s. 3d. a quarter in advance, postage prepaid in the United Kingdom and abroad.

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Current Topics.

International Standardisation.

Hearty congratulations to the British Engineering Standards Association upon the very excellent results it has achieved to date, mainly through the purely voluntary labours of some 2,000 engineers of all branches. Writing as one who has actually served on a panel of this Association, I can testify from personal experience to the very thorough manner in which the minutiæ of the subject are discussed, and ultimate decisions only arrived at after the most careful review of all the circumstances likely to be affected thereby. The work of standardisation in the general field of engineering is never-ending, yet every year the records are extended, enlarged, and brought up to date, new ones being added, so that the available information is now of the greatest value to all branches. In the matter of nomenclature, also, much good work has been done in rendering engineering terms universally intelligible throughout the civilised world.

At the fifth annual general meeting of the B.E.S.A., held recently, it was revealed that there was a deficit of some £1,700 in the available funds of that body upon which it draws for working expenses. It is to be hoped that this comparatively insignificant amount will be speedily wiped out, and the available money be augmented by grants from the Government and from some of the wealthier of our engineering concerns, which certainly derive great benefit from the work of the Association. Seeing that the professional assistance rendered by a body of engineers in all branches in drawing up these standards is voluntarily given, there is every reason that the Association should not be left to struggle on with its invaluable work lacking the necessary money to purchase pens, ink and paper wherewith to record them.

The value of the work being carried on by the B.E.S.A. is materially enhanced by the cordial relations which exist between it and similar organisations in other countries. As instancing the international character of these relations, all of which is to the greater benefit of engineering throughout the world and not to this country alone, a second unofficial conference of secretaries of the standardising organisations of no less than thirteen countries has recently been held in Zurich, Switzerland. It was called by the secretary of the Swiss Committee, Mr. Zollinger, who was appointed chairman of the conference, Mr. Le Maistre, secretary of the B.E.S.A., being appointed vice-chairman. General reports were presented on the position in countries which have only organised their standards since 1921, whilst the possibilities were discussed of making international collaboration more effective. There is no doubt that the Swiss Committee, thanks to its central position, has done good work on this occasion in establishing closer and more friendly relations between the various bodies and enabling the respective secretaries to maintain closer touch and mutual assistance than in the past.

Optimism with Reservations.

The annual reports of the General Electric Company, and the interesting speeches of its chairman, Mr. Hirst, always seem to reflect the general condition of the electrical industry, and it is the more satisfactory, therefore, to note from Mr. Hirst's recent address that he anticipates great success and prosperity for his shareholders in the future, assuming that the Ruhr problem is satisfactorily solved. There is every reason to desire a more settled state of affairs in Europe if only to restore confidence, as Mr. Hirst puts it; at the same time we should not be too ready to fall in with the "be-kind-to-Germany" section of the present Government, even in the hope of improved electrical trade, which might prove illusory.

We must never allow ourselves to forget that Germany forced this war upon Europe, and that, given the power to do so, she would unquestionably repeat her past iniquities. It is symptomatic of the forgive-and-forget characteristics of the British nation that, although possessing the greatest Empire the world has ever seen, we are to-day, individually, the most poverty-stricken of any of the warring Powers. Is it conceivable that, if Germany had succeeded in her fell designs, we should have been left to our own devices and treated as leniently as she has been treated since the signing of Peace? Before the war the electrical industry in this country was impregnated with German influence. One might almost go so far as to say that the electrical industry in Great Britain was initiated by Germans, fostered by German influences, and that German capitalists derived no small proportion of the total profits of that industry.

During and since the war we have succeeded in purging our electrical interests of that influence, and have proved that, so far as the electrical industry is concerned, we are quite capable of standing our ground and competing in the world's markets without the assistance of our one-time neighbour. We do not want any restoration of pre-war conditions in the electrical industry; whatever the outcome of the Ruhr and reparations question, let us have no German hidden hand in the electrical trade. No, we are jogging along very nicely on our own, and although, for various reasons, trade is not so flourishing as it unquestionably would be, given a restoration of the exchanges, and albeit we are individually working several months out of the twelve for the State and not for our own interests, I think the majority of my readers who have had the experience of both pre-war and post-war conditions in the electrical trade would prefer to go on as they are doing, in spite of the harder struggle for existence, than return to that state of German interdependence with which we were familiar before 1914.

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The Safety of Mining Electrical Gear.

Although our own Home Office regulations in regard to the use of electricity below ground are in the main fairly stringent, it would appear doubtful whether they impose such precautionary measures as are apparently practised in the United States. The United States Bureau of Mines investigates various types of motors, such as are used on coal cutters, drills, pumps, loading machines and storage battery locomotives, to determine their safety for use in gaseous mines. Permissible equipments are constructed in accordance with drawings held on file by the Bureau, and their design cannot be modified without due consideration of the effect of such changes on safety. To be classed as permissible and have an approved plate affixed to it, a duplicate of the machine must have received a careful inspection by the Bureau, and all permissible compartments must have successfully passed rigid tests in explosive gaseous mixtures. As exemplifying the need for such drastic precautions, during the last two years three compartments as originally submitted by the manufacturers failed in this respect, the explosion causing the casting to break in several pieces.

Although our own Home Office possess well-equipped experimental and research stations for the conduct of similar experiments, and does actually carry out many similar tests to determine the safety or otherwise of certain forms of construction, I do not think they carry matters to such extremes as to insist upon the testing and approval of every new design of electrical mining gear. We pin our faith largely to the machine-faced joint, with wide cooling flanges, and more or less free access for the normal atmosphere of the pit, whether gaseous or otherwise, the theory being that an internal explosion, if it does take place, is rendered harmless, and cannot ignite the outer atmosphere because of the cooling effect of the flanges between which the expanding gases and flames have to pass. All this beautiful theory falls to the ground, however, in the event of actual fracture of the casting, and there would appear to be more in this mechanical strength of castings and casings than is evident at first sight.

Seeing is Believing.

When the Lighting Service Department of the British Thomson-Houston Company adopted the slogan "Seeing is believing," they did so in face of the general belief that one cannot always believe what one does see. After what I saw, however, at their demonstration (reported on another page) I have decided that one's ability to see is governed by the facilities one has of seeing. This is more than substantiated by a simple experiment which proves that a bright light in the line of vision reduces one's ability to see. This means that a light, up or down or on either side, will allow one to see much more clearly than if the light were actually in the line of vision. This leads me to the conclusion that if the position of a light in the line of vision is wrong, if it is moved slightly out of the line of vision, it would enable one to see better, but the position would still be wrong, and there must, therefore, be a position for the light which would allow maximum visibility. Illuminating engineers have, for many years, been struggling with the subject of adequate and efficient illumination, and now it would appear that the general public are going to reap the benefit of their research work. Correct illumination, and more of it, is the order of the day, and this will result in better conditions for the worker, increased production and more beautiful homes.

The subject of better illumination is one which has occupied the attention of the masses for many generations, yet it is only recently that any great attempt has been made to handle it on scientific lines. The efficiency of present-day illumination is due to the combined efforts of the metallurgist and the physicist. The former has made it possible to draw tungsten steel into the fine filaments seen in the now very familiar gasfilled lamps; the latter has been the means of enabling the filament to be heated to incandescence. It is to be regretted that the product has, in the past, been placed in the hands of persons who have not known how to use it. Yet the same conditions obtain with almost everything in use to-day. The billiards cue or the cricket bat is the product of science embodied with experience, yet the average person who sells them knows no more about them than their market value. In advocating more light and better light, the British Thomson-Houston Company have commenced a new era in electrical illumination. The electrical contractor will be taught how to sell light, and the consumer will be shown what is necessary for his needs. It is as it should be. The electrical contractor should be able to advise a customer. The former is then doing his duty to the community and the latter is obtaining the fullest value for his money.

Four Fans a Minute.

Evidently the recent spell of hot weather created an unprecedented demand for electric fans, and it must have cheered the hearts of the makers to find orders pouring in with a rush. At Magnet House the G.E.C. staff had to cope with the equivalent of one hundred orders per hour, and deliveries were made at the rate of four a minute from 9 a.m. to 6 p.m. on one of the days, so they most certainly did their best towards keeping us cool. I expect that other leading makers can tell much the same tale. Which brings me to another point. How many contractors and retailers of fans had a decent stock ready to meet the emergency demand which nearly always occurs at some period or other during the English summer? The leading makers spend money freely on telling the trade to prepare for such emergencies, but do they? I have my doubts, and it speaks well for the organisation of a great factory and sales department when they can meet such sudden expansion without a corresponding loss of efficiency.

World Use of Electricity.

The Statistical Bureau of the State of New York, having essayed the formidable task of estimating the total consumption of electricity throughout the world, has obtained some remarkably interesting results. As might be expected from the magnitude of the task the figures are already a couple of years old, but it seems probable that the data for 1920 are about the same as those for 1922, the depression in trade during the past few years having

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offset the natural growth in demand for electricity. The total consumption during 1920 was nearly 100,000 million units (kw. hrs.), of which about 15 per cent. was used for lighting and 85 per cent. for various power services. It is not surprising that the U.S.A. led the world in point of total consumption, with the respectable figure of 49,802 million units—14 per cent. of this being applied to lighting and the remainder to power applications in factories, mines, tramways, railways and farms.

As regards average consumption per head of population, Switzerland stands first with 700 units per capita per annum, thanks mainly to her ample resources of water-power. Canada comes next with 512 units per inhabitant per annum; Norway third with 493 units; and the United States fourth with 472 units. The average for Sweden was 364 units in 1920—a figure which I fancy will soon be increased materially. Amongst the "also rans" there are France with 157 units, and Germany with 141 units per inhabitant per annum. I search in vain for the United Kingdom average in the summary before me—whether it is considered negligible, or whether we are regarded as extra-mundane and not to be included in a world summary, is not clear! From the latest statistics issued by the Electricity Commissioners, it appears that some 600 stations in the United Kingdom generated about 4,885 million units. This figure corresponds to about 120 units per inhabitant per annum, but no doubt the actual average, taking all supplies into account, is materially higher.

Of the 1,720 million dwellers on this globe, it is estimated that only 6½ per cent. enjoy the blessings of electric light in their homes and, as regards the world's water-power—which the U.S. Geological Survey estimates to be 439,000,000 horse-power—only a beggarly 5.4 per cent. is as yet harnessed in the service of man. ELEKTRON.

HOW ARORA HELPS THE DOMESTIC LOAD.

Some electric supply authorities hire out domestic electric cookers, while others have adopted schemes of hire-purchase and have found the practice widely appreciated and most satisfactory in operation. There is also now visible a tendency for these schemes to be more widely adopted, and the proceedings at the recent Incorporated Municipal Electrical Association meeting in Scarborough lead us to hope that we are about to witness a live push by the authorities to develop the remunerative domestic load, by publicity, showrooms and service. It was suggested by Mr. J. Christie that to help forward the cooking load the apparatus ought to be installed in the houses of chairmen and vice-chairmen of committees and of assistants in showrooms, and we are pleased to note that manufacturers are likely to assist. At any rate, the Arora Co., of Loughborough, are prepared to go on bold lines to assist supply authorities by offering most attractive preferential terms for their apparatus installed in the houses of the supply people above referred to. In addition the company are prepared to enter into arrangements for hire-purchase of their standard apparatus (of which, our readers are no doubt aware, many thousands of kilowatts are in successful operation throughout the world) to customers of Contractors or Supply Authorities, the trade discount going to the retailer and the customer paying the Arora Co.

It will be remembered that we recently described some of the newest Arora cooking apparatus, and we are pleased to be able to inform our readers that all supplies of Arora firebars now being despatched are wound to a new specification, and every spool of resistance strip is carefully tested prior to releasing into the factory. The company hope that by such selection they have eliminated entirely any possible use in their factory of defective resistance material which may be supplied by the manufacturers. Further, the weight that they are now able to get into each spiral consuming 750 watts is nearly double that which was previously employed, which fact obviously must secure longer life for the firebar. Sagging has been reduced to a negligible amount, and the only difference to the user is that the elements glow about 15 seconds after switching on the fire instead of an instantaneous glow being observed. Already the company have experience of bars having a useful life of from 3,000 hours upwards, which splendid record is likely to be improved with the new type.

Similar improvements are being made in Arora heating units used in boiling plates and ovens, although experience of a five years' continuous use in oven elements without a breakdown is to-day to the company's credit.

ELECTRICITY AT THE FORTHCOMING SHIPPING EXHIBITION.

The increasing adaption of electricity by the shipping industry throughout the world, not only for lighting but for one hundred and one other purposes, accounts for the numbers of exhibits entered for the forthcoming Shipping, Engineering and Machinery Exhibition which will be opened at Olympia on August 31. This Exhibition, last held two years ago, is the world's greatest demonstration of mechanical construction in the realms of shipping and engineering, and even the short period which has elapsed since the last exhibition will be sufficient to show phenomenal progress in the application of electric power to the great needs of ocean-going steamships as well as for the smallest motor-boat.

Many of the leading electrical firms have booked space, and amongst the exhibits will be the following:—A. C. Alexandra and Co., Ltd.; H. C. Slingsby; Relay Automatic Telephone Co., Ltd.; Newton Bros. (Derby), Ltd.; G. D. Peters and Co., Ltd.; J. W. Ray and Co. and F. Smith and Son (London), Ltd.; Automatic and Electric Furnaces, Ltd.; The Premier Electric Welding Co., Ltd.; Quasi Arc Co., Ltd.; The Telephone Mfg. Co., Ltd.; Siemens Bros. and Co., Ltd.; Consolidated Pneumatic Tool Co., Ltd.; Concordia Electric Wire Co., Ltd.; Glennifer Motors, Ltd.; The British Thomson-Houston Co., Ltd.; The Ailsa Craig Motor Co., Ltd.; Slack and Parr, Ltd.; Crosbie and De Mowbray, Ltd.; Parsons Motor Co., Ltd.; Theo and Co.; The Reliance Telephone Co., Ltd.; The London Electric Firm; Laurence Scott and Co., Ltd.; Edison Accumulators, Ltd.; Electrical Apparatus Co., Ltd.; The Anglo-Swedish Electric Welding Co., Ltd.; and The Elkay Electrical Mfg. Co., Ltd.

One of the features of the Exhibition will be the

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special days devoted to visitors of trade associations and scientific institutions, and in this connection the Institution of Electrical Engineers and the Cable Makers' Association are both being entertained.

TELEGRAPHY.—GRADE I. (1923).*

Being Solutions to the Questions set by the City and Guilds of London Institute in the Grade I. Examination in Telegraphy held in May, 1923.

(*Continued from page* 378.)

Q. 5.—Two wires of 200 ohms and 300 ohms resistance respectively are joined in parallel to the terminals of a battery of 15 volts electromotive force and 30 ohms internal resistance. What are the strengths of currents flowing through the battery and through each resistance?

A. 5.—The external resistance is equal to the joint resistance of 200 ohms and 300 ohms, that is

$$\frac{200 \times 300}{200 + 300} = \frac{60{,}000}{500} = 120 \text{ ohms}$$

The total resistance of the circuit is therefore

$$120 + 30 = 150 \text{ ohms}$$

and the current through the battery is by Ohm's Law equal to

$$\frac{\text{E.M.F.}}{\text{Total Resistance}}$$

$$= \frac{15}{150} = \frac{1}{10} \text{ ampere} = 100 \text{ milliamperes.}$$

This current divides through the external resistances in the inverse ratio of their resistances, or as 3 : 2.

Hence

Current through 200 ohm resistance

$$= \frac{3}{5} \times 100 = 60 \text{ milliamps.}$$

Current through 300 ohms resistance

$$= \frac{2}{5} \times 100 = 40 \text{ milliamps.}$$

Q. 6.—What is a shunt and how are shunts wound? A galvanometer of 60 ohms resistance has a full scale deflection produced when a current of 10 milliamperes flows through it. What must be the resistance of a shunt which would enable the galvanometer to be used to indicate currents up to 500 milliamperes?

What is the function of the shunts on the coils of a differential galvanometer used in a duplex circuit?

A. 6.—A shunt is a resistance coil connected across the terminals of the coils of an instrument in order to reduce the current passing through it. In the case of a calibrated galvanometer the shunt is generally applied to diminish its sensibility and thus render it suitable for measuring currents of greater strength than the maximum for which it is designed.

Shunts are wound non-inductively and ordinarily with German silver or manganin wire. For telegraphic instruments shunts are usually wound on flat bobbins with copper wire; the use of the latter material for galvanometer shunts eliminates temperature errors that may arise if the instrument and shunt coils are wound with wires of different materials.

In the numerical part of the question, the resistance of the shunt must be such that when the current through the main circuit is 500 milliamperes, the current through the galvanometer is 10 milliamperes; hence the current through the shunt is 500 — 10 = 490 milliamperes.

This means, that as the current through the shunt is 49 times that through the galvanometer, the resistance of the latter must be 49 times that of the shunt, therefore the resistance of the shunt must be equal to

$$\frac{60}{49} = 1.22 \text{ ohms.}$$

The coils of a differential galvanometer used on a duplex circuit have each a resistance of 50 ohms and each is shunted by a resistance of 300 ohms, giving a joint resistance of 42.9 ohms. The object of shunting the coils is to reduce the effect of their inductance which on short or high speed circuits is detrimental to signalling and liable to cause sparking at the key contacts.

(*To be continued.*)

* *The standard text books for this Grade are: "The Telegraphists' Guide," by Bell & Wilson (20th thousand, 3s. 6d. net), and "Questions and Solutions in Telegraphy and Telephony, Grade I.," by Few (5th edition, revised, 5s. 6d. net).*

ELECTRICAL ENGINEERING—FINAL GRADE.

SOLUTIONS TO 1923 EXAMINATION QUESTIONS OF THE CITY AND GUILDS INSTITUTE.

BY EDWARD HUGHES, B.Sc. (Eng.), A.M.I.E.E.

Q. 1.—If the dielectrics of a concentric cable be made of equal thickness, what ratio should their specific inductive capacities bear to one another in order that the maximum stress should be the same in each? Express your answer in terms of the diameter of the core *d* and of the cable *D*.

A. 1.—This question is very loosely worded, as it is not at all obvious that the two dielectrics referred to must form a graded insulation between the inner and outer conductors, and are not the insulation on the inner and outer conductors respectively. In the latter case, the maximum potential gradient in each dielectric would have been independent of the specific inductive capacities (S.I.C.) of the respective dielectrics.

Also, the dimension given as *D* is ambiguous; it may refer to the outside diameter of the cable, or to either the internal or external diameters of the outer conductor. In order to avoid complications due to the thickness of this outer conductor, it will be assumed that *D* represents the internal diameter of this conductor. Hence the arrangement of the two conductors and the graded insulation will be as indicated

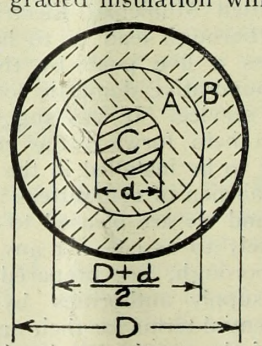


FIG. 1.

in Fig. 1, where *A* and *B* represent the two dielectrics of equal thickness and *C* is the inner conductor.

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To start with, let us consider a conductor surrounded by a homogeneous insulation as in Fig. 2. Then for an

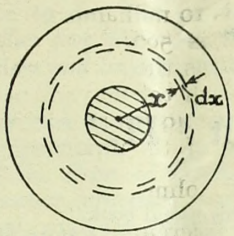


FIG. 2.

element of insulation of radius x, thickness dx and axial length l—

Capacity of element

$$= dC = \frac{\text{Area of cylindrical surface} \times \text{S.I.C.}}{4\pi \times \text{thickness}}$$

$$= \frac{2\pi x l K}{4\pi dx} = \frac{xlK}{2dx}$$

when K = S.I.C. of dielectric.

If Q = charge in electrostatic units on length l of cable, and dV = P.D. across the above element of dielectric due to charge Q,

then, capacity of element = charge per unit of potential difference,

$$\text{i.e., } dC = \frac{Q}{dV}$$

$$\therefore\ dV = \frac{Q}{dC} = Q \times \frac{2dx}{xlK}$$

$\therefore$ potential gradient in element = P.D. per unit thickness

$$= \frac{dV}{dx} = \frac{2Q}{xlK}$$

This potential gradient is obviously a maximum when x is a minimum, namely, at the surface of the inner conductor.

We can now apply this result to the dielectrics shown in Fig. 1, where the internal radius of dielectric A is $\frac{d}{2}$ and that of B is $\frac{D+d}{4}$. If K_1 and K_2 be the S.I.C. of A and B respectively, then—

$$\text{maximum potential gradient in } A = \frac{2Q}{\frac{d}{2} \times lK_1}$$

and

$$\text{maximum potential gradient in } B = \frac{2Q}{\frac{D+d}{4} \times lK_2}$$

Since these maximum stresses are to be equal,

$$\frac{2Q}{\frac{d}{2} \times lK_1} = \frac{2Q}{\frac{D+d}{4} \times lK_2}$$

$$\therefore\ dK_1 = \frac{D+d}{2} K_2$$

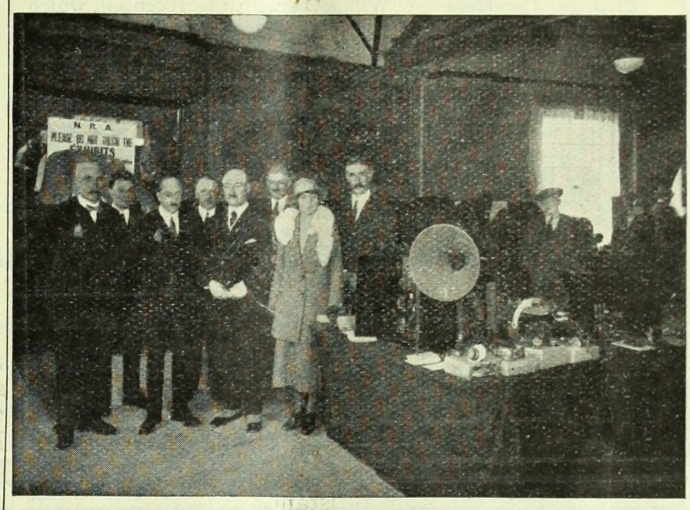
$$\therefore\ \frac{K_1}{K_2} = \frac{D+d}{2} \times \frac{1}{d}$$

i.e., the specific inductive capacities of the dielectrics must be inversely proportional to their internal diameters.

(To be continued.)

WIRELESS IN ULSTER.

An extremely well-organised wireless exhibition was opened at Ye Olde Castle Restaurant, Belfast, on Wednesday, June 20, by the Rt. Hon. the Lord Mayor of Belfast (Alderman W. G. Turner, J.P.). The exhibition was conducted under the auspices of the Northern Radio Association, which, under the presidency of Captain J. N. Inglis, forms the centre of wireless interest in Northern Ireland, and when the Lord Mayor opened the exhibition he explained that its objects were two-fold—to enable members of the Northern Radio Association to inspect the various types of apparatus on the market and to arouse the interest in wireless of friends and visitors who as yet were not radio enthusiasts.



Most of the leading manufacturers were represented on one or more stands, and excellent displays of sets, both crystal and valve models, component parts, accessories and loud-speaker equipment were exhibited.

A unique feature of the exhibition was that no demonstrations or active selling propaganda were allowed, so that visitors were enabled to inspect goods at their leisure without the dread of encountering the specialised salesman.

Our illustration, for which we are indebted to the G.E. Co., shows part of the exhibition, with the Mayoral group and officials.

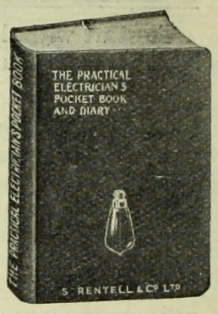
The Electro Harmonic Society.—Congratulations on the satisfactory balance-sheet which is to be presented at the annual general meeting to be held this (Friday) afternoon at I.E.E. building. Also most cordial thanks to Mr. R. W. Hughman for the able way in which he deputised as hon. sec. in the absence of Mr. W. E. Lane overseas. It was a very successful season, and as all the concerts but one in the forthcoming season are to be held on Fridays, we can most probably look forward to an even more prosperous time. The Caxton Hall has given general satisfaction, and the concerts will again be held there.

Value for Money.—In these hard times have you ever calculated that the *Practical Electrician's Pocket Book* represents about the best value in electrical literature which it is possible to obtain? The price is 3s., from any bookstall or bookseller in the kingdom (3s. 4d., post free, from this office), and for that modest sum you receive 571 pages of eminently practical information with plenty of diagrams and tables of standard data. Think of it. Almost sixteen pages for a penny, and backed by the approval of over 160,000 readers who have purchased copies since it was first started 25 years ago. If you have not yet bought a copy, do so before the present edition is out of print. It is getting near it.

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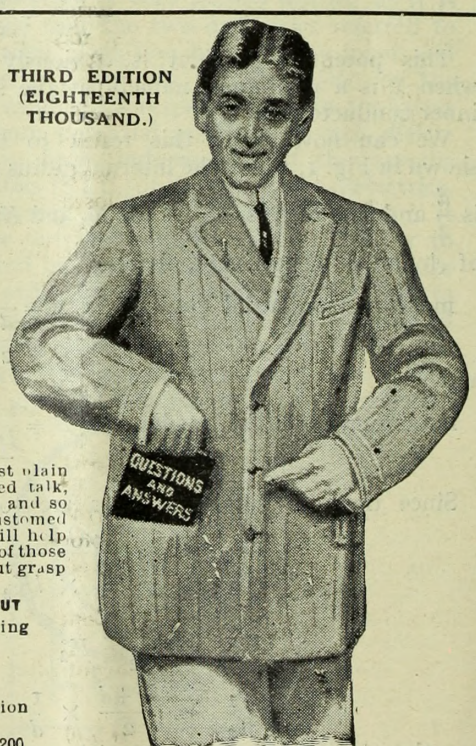
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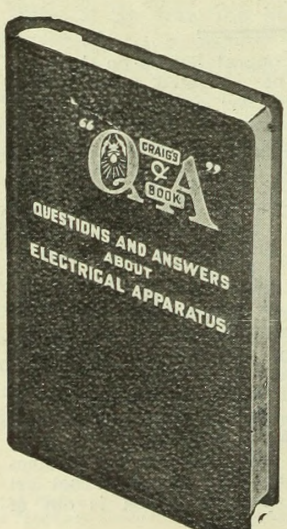
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Reviews of Books, &c.

[Books noticed in this column will be sent from ELECTRICITY *Office to any part of the world, for the published price, plus five per cent. for postage (minimum 2d.), and orders will be appreciated.]*

THE JOURNAL OF THE INSTITUTE OF METALS. Vol. XXIX. 914 pp., illustrated, + 57 plates. Edited by G. Shaw Scott, M.Sc. (Inst. of Metals, 31s. 6d. net.)—We have here another unusually large volume of this well-known *Journal*, and the expedition with which it has been issued is very creditable, seeing that it deals comprehensively with the annual meeting held in March last, covers over 900 pages and is illustrated by 57 plates. Similar American transactions usually appear a year or more after the meeting upon which they are based! By the way, we understand from Dr. Rosenhain, F.R.S., recently returned from a three months' lecture tour in the U.S.A., that there is nothing in America—or in the world for the matter of that—to compare with the *Journal of the Institute of Metals*, which is regarded very highly by American metallurgists and engineers. The new volume well maintains the excellent standard of the past. It includes more papers than have ever before appeared in one of the Institute's volumes. There are twenty papers in all, covering every phase of metallurgical work, and nearly every alloy. Any alloy that escapes mention in the papers is to be found—with the assistance of a magnificent index—in the wonderfully complete abstracts section of the *Journal*. The latter section is a veritable treasure trove to all workers in, and users of, metals—as, in fact, is the whole book.

BRITISH STANDARD SPECIFICATIONS.—Following the issue of B.S. Specification Nos. 109-1923 and 110-1923 for Air-Break Switches and Air-Break Circuit Breakers, the British Engineers Standards Association has prepared thirteen additional Specifications relating to switch and control gear, as follows:—

No. 124-1923.—Totally Enclosed Air-Break Switches.
No. 130-1923.—Totally Enclosed Air-Break Circuit Breakers.
No. 126-1923.—Flame-proof Air-Break Switches.
No. 127-1923.—Flame-proof Air-Break Circuit Breakers.
No. 117-1923.—Drum Starters for Electric Motors.
No. 140-1923.—Liquid Starters for Electric Motors.
No. 141-1923.—Switch Starters for Electric Motors.
No. 147-1923.—Multiple Switch Starters for Electric Motors.
No. 155-1923.—Contactor Switch for Electric Motors.
No. 167-1923.—Auto-Transformer Starters for Electric Motors.
No. 118-1923.—Drum Controllers for Electric Motors.
No. 123-1923.—Face Plate Controllers for Electric Motors.
No. 129-1923.—Contactor Controllers for Electric Motors.

The Specifications for switch and circuit breakers are for voltages not exceeding 660, and follow the same general lines as Nos. 109-1923 and 110-1923, but there are a number of additional clauses special to enclosed switchgear, for example, containing case, interlocking, clearances, etc. In the case of switch specifications a test of breaking capacity has been included, and in the flame-proof switch and circuit breaker specifications, a test of flame-proofness.

In accordance with the usual procedure all these specifications have been submitted to the interested traders' and users' associations, technical societies and Government departments for comment and approval. Those for motor starters whilst in draft formed the subject of an open discussion at the Institution of Electrical Engineers. As a result many valuable suggestions, the adoption of which made for the improvement of the specifications, were received. Other comments were recorded for future revision, as it is intended that a revision of all of them shall take place after a year or two's use.

In the preparation of the six starter specifications full use was made of the experience gained in connection with the pioneer specification for face plate starters (No. 82-1919). This latter will now be revised and brought up-to-date in conformity with the new issues.

Every endeavour has been made to secure the uniformity of the starter and controller specifications as far as possible. Each specification is sectionalised as follows:—General Definitions; Definitions of Enclosures; Rating, Sizes and Marking; Design and Construction; Tests.

Copies of the specifications are obtainable from ELECTRICITY office, price 1s. 2d. each post free.

DIRECT CURRENT MACHINERY. By H. Pender. 314 pp., 146 figs. (Chapman and Hall, 15s. net.)—We have long felt that the methods and problems of design are given far too much prominence in the average text-book on electrical machinery, particularly when it is remembered that not one student in a hundred is ever faced with the necessity or, indeed, the opportunity of designing such machines. We, therefore, extend a particularly hearty welcome to this book, which gives a thorough treatment of the theory and performance of D.C. machines, including, of course, the basic principles upon which the design depends, but with an entire absence of matter relating only to design. This volume is exactly what is needed by the average student who may reasonably expect to be called upon to operate and test D.C. machinery, and to pass opinion upon the suitability of various types and individual machines for a particular service. The greater part of the volume is, therefore, devoted to the performance, application and testing of various types of D.C. generators and motors. Throughout, the treatment given is quantitative and accurate, and the book contains a great deal of new and practical information not to be found elsewhere. After three excellent introductory chapters, we come to what may fairly be regarded as the most important sections of the book, viz., the chapters on commutation, armature reaction, voltage regulation of generators, operating characteristics of motors, and the testing of D.C. dynamos. The chapter on miscellaneous D.C. machines contains a deal of useful information which it is generally hard to come by. An excellent feature of the book is the inclusion of a number of problems at the end of each chapter.

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We have received from Messrs. Percival Marshall and Co., two more of their justly popular series of 9d. books. The first is entitled "Gear Wheels Simply Explained," and is published with the intention of explaining to the apprentice or amateur the principles which underlie the subject more than how to design gears. The book deals with its subject very thoroughly, and starting at the beginning explains the formation and proportions of the teeth of gear wheels. After dealing with the involute tooth it goes on to describe lantern on pin wheels and racks. Worm and bevel gears are also described, and the last chapter devoted to helical, spiral and epicyclic gearing, which is explained most clearly without any intricate formulæ. The second book, "Screw Cutting Simply Explained," will, we feel sure, soon become a classic among all who are passing through the elementary stages of turning, and of very practical use to any man who, although versed in the generalities, wishes to improve his work. A good thread should go straight in the nut without the use of a chaser, and without any slack—an ideal not reached by the majority of mechanics. Written by a man who knows his subject from A to Z, it should prove a welcome addition to a very useful series.

BENCOLITES.

We have received several illustrated brochures from the Benjamin Electric, Ltd., giving us details of improved illumination of shops, showrooms, offices and public halls. Some of the fittings, especially the Marbella, give a powerful but gentle light with the entire absence of objectionable shadows and sharp contrasts. The details of their elliptical angle reflectors are very interesting. These reflectors are designed and made for the illumination of vertical surfaces. The claim, that the superiority of this reflector lies in the fact that, in addition to a heavy flux of light directly in front of the reflector, the elliptical design provides a wide distribution horizontally and builds up the illumination, *in between*, is worthy of serious consideration. The details of shop-window reflectors are very interesting, and should be considered by shopkeepers and others who wish to consider their windows as a public-drawing medium. Full details of their specialities can be obtained from the company. Their address is: Brantwood Works, Tariff Road, Tottenham, London, N.17.

Various Items.

August Holidays.—The works of the London Electric Firm will be closed from Saturday, 4th prox., and reopen on Monday, 13th prox., but a small staff will be kept in attendance to deal with urgent business.

Tenders Wanted.—The Municipal Council of Johannesburg invite tenders for field coils for traction motors. Specification, etc., can be seen at the D.O.T. (Room 52), 35, Old Queen Street, London, S.W.1.

Submarine Cable Wanted.—The P.M.-G.'s Dept. at Sydney, N.S.W., invite tenders for submarine telephone and telegraph cable. Specification, etc., can be inspected at the D.O.T. (Room 52), 35, Old Queen St., London, S.W.1.

A Healthy Sign.—The works of the Electric Heating Co., George Street, Croydon, will be closed on the 31st inst. and reopen on Tuesday morning, August 7, partly for stock-taking purposes, but principally to complete alterations and addition to plant, which will enable the company to increase its output by 50 per cent. in order to cope with increasing business.

Just Published.—No. 136 of the *Crystal Palace Engineering School Magazine* has just been issued. It contains an interesting paper on "Harbours and Docks," read by Mr. Alfred Pearce, M.I.C.E. (an old student), as well as a report of the annual dinner and various letters from old students in different parts of the world, a list of recent appointments, and the usual school news of the term.

A Pipe Smoker's Pal.—In our issue of July 20th we referred to the catalogue of "Sunglow" pipelighters, etc., now being placed on the market by Messrs. Victor Ashby and Son, Ltd., of Pioneer Works, Towcester. Since then we have been making actual use of one of the pipelighters in this office, and can therefore speak of it from practical experience. It has proved quite an acceptable innovation and saved many editorial matches, to say nothing of the untidy litter consequent thereon. Most certainly, these lighters should prove an attractive and quick-selling line for retail dealers in electrical accessories.

An Important Law Action.—All dealers in, and users of, incandescent lamps will be interested in the advertisement which appears in our pages announcing the result of the action which was brought by the British Thomson-Houston Co., Ltd., of Rugby, against Messrs. Charlesworth, Peebles and Co., of Glasgow, for infringement of certain patents in connection with the manufacture of tungsten filament lamps. Space does not permit us to quote at length the very clear and reasoned judgment which was given in the Scotch courts by Lord Blackburn, but the result was in favour of the plaintiff company on all points.

Staff Outings.—The indoor and outdoor staffs of Francis Polden and Co., Ltd., joined together on Saturday, July 14, for an outing to Eastbourne, where nine hours' sea and sunshine were thoroughly enjoyed. It is pleasing to learn from the remarks of Mr. Polden at lunch that a larger gathering was present this year than last, and the continued and steady employment gave him much gratification, especially in view of the general depression. Mr. Shaw, a veteran of the company, proposed the toast of Mr. Polden, which was heartily received, and Mr. Bovey, in replying to the toast of "The Staff," promised the continuance of their spirit of keenness. The rest of the day was spent in walks and swimming, motor trips, etc., and after a very comfortable return journey the party dispersed in complete agreement that the outing had been most enjoyable.

——On the same day the employees of the Hart Accumulator Co., Ltd., of Stratford, London, held their 25th annual outing, when, in admirable weather, a most enjoyable day was spent at Hastings. Following an excellent luncheon at Ferrari's Restaurant, brief remarks on the continued prosperity and expanding business of the company were given by the chairman, Mr. F. J. Holmes, director and general manager of the company, to which Mr. R. Wheatley, works superintendent, suitably responded. The party then dispersed to spend the remaining hours according to their own inclinations, the county cricket match (with wonderful fast bowling by A. E. Gilligan) claiming its fair quota of supporters. The return journey commenced all too soon for most of the party, and although the number in attendance was much smaller than usual, it was by general consent regarded as one of the best outings the company has ever held. Thanks were due to the indefatigable work of the Organising Committee, Messrs. W. Macdonald (hon. sec.), C. Cartwright (hon. treas.), W. Bishop, A. Blythe, A. Crafer, W. Hayward, F. Keeble and J. Gibbons.



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A POPULAR SCIENTIFIC WEEKLY JOURNAL
ELECTRICITY
A PRACTICAL TRADE JOURNAL

AUGUST 3, 1923.

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THE BROADCASTING CONTROVERSY.

(SPECIALLY CONTRIBUTED.)

In the present state of the broadcasting controversy an important point appears to have been overlooked by all those who have expressed their opinions on the matter. Amongst the charges which the Broadcasting Co. make is one in the form of a tax on the valve or valves used in the majority of sets as now constructed, and which are well known to contain an important improvement on the original Fleming valve, contrived by De Forest in 1906, and the period of monopoly granted to the inventor or legal holder of the patent expired in 1921.

Now the essence of the patent law is that a monopoly of manufacture has been granted and guaranteed for a definite period by the State as a reward to the inventor, which afterwards has to become public property, and free to anyone to make, use and trade with; and to ensure this being carried out the Patent Office demand a full and clear explanation of the invention to be made, and published as a necessary condition to the granting of any patent.

In special cases, where from various causes the inventor has been unable to obtain a reasonable reward, an extension of the ordinary term of protection of fourteen years is granted, and regulations as to the method of procedure in such are provided for in the existing laws.

By making a specific charge for the use of valves, the patent for which has expired, the Broadcasting Co. are practically extending the protective term of this patent, and depriving the public of their right to use same. The interested parties are debarred from obtaining an extension of the term, since they cannot possibly pretend that this patent has been an unremunerative one during the past fourteen years, but it appears that with the assistance of powerful trading officials of the Government they are still able to extract what is really a royalty on these valves.

Now this point is of the utmost importance to the public, since it shows how a wealthy trading body can drive the proverbial "coach and four" through any Act of Parliament, provided they can obtain the assistance of a powerful and unrepresentative Government Department, and this innovation in our methods of Government should be sternly suppressed at once. Whatever form the remuneration of the Broadcasting Co may take, it should keep clear of ever attempting to nullify any existing Act of Parliament.

A large part of the trouble now under consideration arises from the Government having embarked in and carried on trading enterprises, which in most instances have shown a tendency to override existing laws, and claim exemption from same, which would not be tolerated if made by any private firm. If the telegraphs had remained as originally formed, quite independent of the Government, the latter would never have allowed them later on to claim the exclusive right of sending currents through all wires, and yet again to stretch this prerogative to the extent of monopolising all methods of electrical communication. These defects have, perhaps, been made worse by the Postmaster-General, acting on his undefined authority over all methods of electrical communication (whether known or yet to be discovered), having negotiated a private bargain with a trading company, to carry out what he cannot do himself, and this appears to be very unfair to the public who have to pay for it all, since there is no control exercised by the latter over the expenditure involved or the quality of the programmes submitted.

As could safely have been predicted, this arrangement has been strongly criticised, but could any equitable settlement be expected from the department that keeps up high charges on letters, parcels, telegrams, and telephones, to give the Press cheap telegrams?

The method of charging is put in the form of an Excise licence, but differs materially from same, in that favouritism, disguised under the term, "the Postmaster-General's discretion," comes into play, especially in the issuing of experimental ones.

Complaints are made that applicants of limited technical knowledge and experience have succeeded in obtaining these immediately, while others fully qualified in every respect either are rejected or have to wait three or four months before getting one. A further condition is imposed, viz., that all experimenters should disclose particulars of their intended researches beforehand, and an excuse for demanding this is made on the ground of possible interference to other recipients, but this explanation appears rather weak, and, unfortunately, it can be interpreted into carrying a very disagreeable imputation, that since it is quite possible amateur research might result in finding out facts which would depreciate or perhaps render worthless some patents now held by the Broadcasting Co., this condition was devised to enable them either to forestall and utilise the ideas of other people or to prevent them from carrying them out.

Considering how much all trades and manufactures have owed in the past to the work of disinterested amateurs, this is the last thing any Government Department should appear to countenance. To take an example, that sheet anchor of modern photography, the dry plate process was the outcome of years of patient research carried out solely by amateurs wanting to abolish the inconveniences attached to wet plates, and again the perfection of the modern microscope has

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largely been obtained through the labours of people who studied it as a hobby; and to furnish an example quite familiar to all our legislators, the works of "Big Ben," their official timekeeper, were made by Messrs. Dent, clockmakers, to the designs of a lawyer, Mr. Denision (the late Lord Grimthorpe). In fairness to all parties it must be borne in mind that three sets of ideas and aims are here being forced into the same boat to voyage together the best way they can:—

(1) The legislature, whose aim is the general public benefit and perfect justice to all parties as far as possible.

(2) The Postmaster-General, who is responsible for the smooth working, efficiency and economy of his department.

(3) The Broadcasting Co., who have to make a commercial profit in return for the work they are doing and the capital they have expended.

Is it possible to find a practical working solution on the following lines?

A 5s. yearly licence to be granted to all applicants without any restrictions as to the apparatus they may use, the revenue from this to go to the Broadcasting Co.

Anyone wishing to send a message should be allowed to do so on communicating to his nearest station his licence number and that of the person he wishes to signal to, the station then, if necessary, allotting him a definite time for doing so and posting per return a charge for sending (this amount would in time be modified, as experience would show), and these sums would go to the Postmaster-General, who would thus receive a revenue capable of great expansion without any capital account or responsibility, and, above all, voluntarily paid.

The public again, by the taking out of more or less licences, would exercise an indirect control over the quality of the concerts, etc., which the Broadcasting Co. give.

All parties should look ahead, as a cheap and simple means of universal communication is now within the reach of everyone, and, if properly handled, nearly every house, especially in country districts, will put up its own plant, an expenditure the Postmaster-General could not possibly undertake; and the Broadcasting Co. would find it a far better policy to induce every member of the public to take an active interest in broadcasting than by exploiting their present position and causing a feeling of resentment by imposing a set of senseless and short-sighted regulations.

SOME NOTES ON PHASE ADVANCERS.

(*Concluded from page* 388.)

If, therefore, such a machine be connected to the slip-rings of an induction motor and rotated at a speed above synchronism, an E.M.F. suitable for phase advancing will be injected into the rotor circuit. The advancer may be driven by a small auxiliary motor, or by a belt off the shaft of the main motor. There is no difficulty in obtaining the necessary speed, as it must be remembered that synchronous speed corresponds to the frequency of the rotor currents, which is only a few per cent. of the supply frequency: the actual speed will, of course, be dependent on the magnitude of the E.M.F. required. The power taken to drive the advancer is small, not much more than is sufficient to overcome friction, since the E.M.F. generated is in quadrature with the current.

In dealing with the theory we have omitted the mention of any stator, since it is not essential. In practice, however, the reluctance of the magnetic path in an ordinary D.C. armature without stator would be too high, and then a field frame is usually supplied, if only to afford a return path for the flux. In many cases, however, this is equipped with compensating windings, since, with the large rotor currents to be dealt with, commutation becomes a difficulty. Where, however, these are not necessary, the armature conductors are often buried in closed tunnels in the core with sufficient iron outside them to carry the flux; no stator is then necessary—it may be considered as revolving integrally with the armature.

The Kapp type of advancer works on a different principle. It depends upon the fact that a coil placed in a D.C. field and free to rotate will, if supplied with an alternating current of low enough frequency, act as a dynamic condenser.

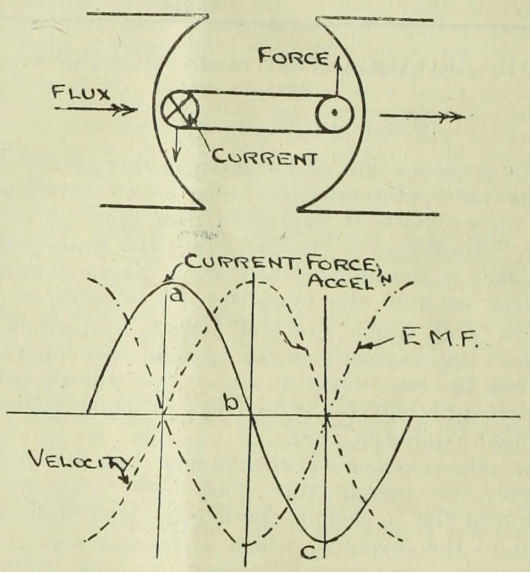


Fig. 3.

This will be made clear from Fig. 3. In this there is shown a sine wave representing the current passing through the coil: with a constant field this curve to another scale will represent, provided the vibrations have a small amplitude, the force acting on the coil, and to yet another scale the acceleration of the coil. It follows, therefore, that the angular velocity of the coil is given by another sine wave, in quadrature with the first. This is shown by the dotted curve in Fig. 3. And, since the generated E.M.F. is proportional to the rate at which the conductors cut the field, the E.M.F. curve will also be in quadrature. What has to be determined, however, is as to whether the quadrature is leading or lagging with reference to the current wave. This is made clear from the following considerations.

While the coil is accelerating (i.e., from *a* to *b* on the current curve) the apparatus is acting as a motor and converting electrical into mechanical energy; thus the generated E.M.F. must oppose the current. On the other hand, when the coil is decelerating, it is acting

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as a generator and converting electrical to mechanical energy: the generated E.M.F. is then acting with the current. From this it follows that from *a* to *b* the E.M.F. curve must be on the opposite side of the axis to the current curve, and from *b* to *c* on the same side. If a sine wave is drawn to fulfil these conditions, it will be seen to lead the current wave by 90 deg. We thus have, in such a piece of apparatus, the essential features of a phase advancer.

On the Kapp vibrator, the coil is replaced by a small D.C. armature, and all the considerations which were given above for vibrations of small amplitude, in the case of one coil, now hold good for large vibrations of possibly several complete revolutions.

For a three-phase rotor there would be three armatures arranged in a common field frame, either vertically or horizontally: their length is made great compared with their diameter to keep the moment of inertia low, and when mounted on ball bearings they vibrate easily at rotor frequency. The armatures are usually connected to the three phases of the rotor in delta, thus reducing the current to be dealt with by each armature. Commutation, however, is inherently good, since, on reference to the curve, it will be seen that maximum current occurs at zero speed, and zero current at maximum speed.

In this respect the Kapp vibrator has a great advantage over the rotary advancer; it also requires no auxiliary motor. On the other hand, it possesses three armatures and commutators instead of one, and also requires a D.C. supply for the field.

TELEGRAPHY.—GRADE I. (1923).*

Being Solutions to the Questions set by the City and Guilds of London Institute in the Grade I. Examination in Telegraphy held in May, 1923.

(*Continued from page 398.*)

Q. 7.—Describe, with a sketch, a terminal pole carrying eight telegraph wires. How are the lines and apparatus protected from lightning and power circuit currents?

A. 7.—A terminal pole is the last pole on a route whether the wires be led from it direct to an office or to a section of underground pipes. Whenever possible, extra stout, round creosoted poles are used, but where objections exist to their use, square American pitch-pine poles are employed.

Fig. 1 shows the part side elevation and plan of a square terminal pole carrying eight telegraph wires. The pole has a length of 32 ft. and tapers from 12 inches square at the base to 8½ inches square at the top, which is surmounted by a wooden finial. The arms are secured to the pole by galvanised iron bolts with nuts and washers, and are 48 inches in length and 3 inches by 3 inches in section. The holes for the insulator spindles are spaced as shown in the plan. The top arm is fixed at right-angles to the pole about 9 inches from the top and the lower arm at a distance of 12 inches from the upper. Both arms are fixed on the opposite side of the pole to the line wires, so that the pull of the latter is against the pole and not taken by the bolts.

Owing to the large stresses to be borne, special terminal insulators with J-spindles are used for terminating the wires. A terminal insulator has two grooves it is larger and stronger than the ordinary form of insulator, and its outer shed overlaps the inner shed. The advantage of using the J-spindle is that the stress due to the line wire is applied directly in the plane of the arm-bolt and there is no tendency towards canting.

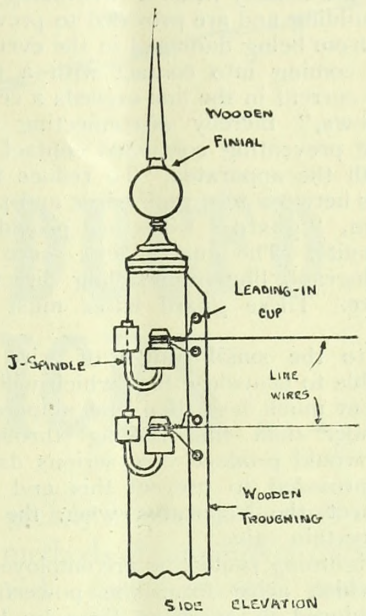


FIG. 1.

A line wire is terminated by passing it around the insulator groove and binding the free end tightly to the main wire by means of a binding wire of the same material. A lead-covered leading-in wire, which is bound round the end of the line wire and soldered thereto, passes through a leading-in cup to a covered wooden trough fixed to the pole and thence to the building to be served.

At the junction of an overhead line to an underground paper-core cable special precautions are necessary to prevent the access of moisture to the cable, in order to maintain its high insulation. To ensure this the underground cable is led up the terminal pole to a distribution plug from which separate lead-covered twin core cables are carried to the appropriate arms on the pole. Each leading-off wire passes into a chamber

* *The standard text books for this Grade are: "The Telegraphists' Guide," by Bell & Wilson (20th thousand, 3s. 6d. net), and "Questions and Solutions in Telegraphy and Telephony, Grade I." by Few (5th edition, revised, 5s. 6d. net).*

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in a special form of terminal and leading-in insulator where the joint is made with the overhead wire, the latter being bound to the insulator in the manner already described.

A longitudinal stay, attached to the pole by means of a wrought-iron band, is fitted in order to counteract the canting effect of the stresses on the pole due to the line wires.

In order to safeguard aerial lines and apparatus, fuses, heat coils and lightning protectors are used. The fuses are usually fitted in weather-proof cases outside the building and are provided to prevent apparatus and lines from being damaged in the event of the overhead line coming into contact with a power circuit. When the current in the line exceeds a certain limit the fuse "blows," thereby disconnecting the telegraph circuit and preventing continued contact of the power circuit with the apparatus. To reduce the possibility of contacts between telegraph wires and power wires to a minimum, "guard" wires are provided above the power circuits. The guard wires serve to prevent a broken telegraph line from falling directly on to the power wire. These guard wires must be efficiently earthed.

Owing to the small gauge of wire needed it is impracticable to provide a fuse which will be "blown" by a current much less than one ampere. A current much smaller than this flowing through telegraph apparatus would produce very serious damage. Heat coils are provided to prevent this and are designed to disconnect the apparatus when the line current exceeds a certain value.

Carbon lightning protectors are employed to eliminate dangers which arise from the powerful oscillatory currents induced in overhead lines by lightning discharges; to such currents the air gap formed by the carbon plates of the protector act as a comparatively low resistance shunt to the apparatus coils, which, by virtue of their inductance, offer a high impedance.

Heat coils and protectors are fitted at the test and cross connection frame in large offices, and in fire-proof cases in small offices where there is no cross connection frame.

At the junction of main open and underground lines, pole test boxes are usually fitted to the terminal pole in order, not only to afford testing facilities, but to carry the fuses and lightning protectors necessary to safeguard the covered wires.

(To be continued.)

ELECTRICAL ENGINEERING—FINAL GRADE.

SOLUTIONR TO 1923 EXAMINATION QUESTIONS OF THE CITY AND GUILDS INSTITUTE.

BY EDWARD HUGHES, B.Sc. (Eng.) A.M I.E.E.

(*Continued from page* 399).

Q. 2.—The middle wire of a 3-wire continuous current system is earthed through a resistance of 10 ohms in series with an ammeter. On the positive side there is a fault to earth of 20 ohms, and on the negative side of 18 ohms. If the balancer maintains 200 volts between the mid-wire and each of the outers, calculate the potentials of the positive, negative and middle wires at the balancer terminals and the ammeter reading.

A. 2.—The resistances of the positive and negative outers to earth can be represented as in Fig. 3. Since the resistance to earth on the negative side is

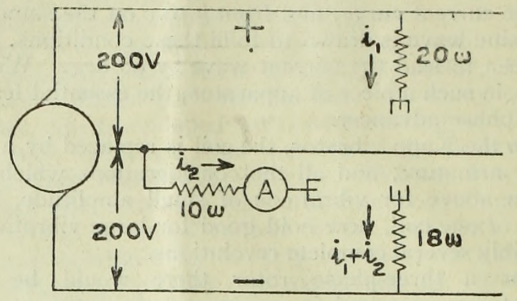


FIG. 3.

less than that on the positive side, the current in the former must be greater than that in the latter, so that current must flow from the middle wire to earth as indicated by i_2.

If i_1 be the current flowing from the positive outer to earth, then current flowing from earth to the negative outer is (i_1+i_2).

Hence potential of positive outer above earth
$$= i_1 \times 20$$
potential of middle wire above earth
$$= i_2 \times 10$$
and potential of negative wire below earth
$$= (i_1+i_2) \times 18$$
$\therefore$ P.D. between positive outer and middle wire
$$= (i_1 \times 20) - (i_2 \times 10)$$
so that $20i_1 - 10i_2 = 200$ .....(1)

Similarly P.D. between middle wire and negative outer
$$= (i_2 \times 10) + (i_1+i_2) \times 18$$
so that $10i_2 + 18(i_1+i_2) = 200$
$$\therefore 18i_1 + 28i_2 = 200$$
$$\therefore i_1 = \frac{200-28i_2}{18}$$

Substituting for i_1 in equation (1), we have
$$20 \times \frac{200-28i_2}{18} - 10i_2 = 200$$
$$\therefore 2000 - 280i_2 - 90i_2 = 1800$$
$$\therefore i_2 = 0.54 \text{ amp.}$$
$$= \text{reading on ammeter,}$$
and $i_1 = \frac{200 - 0.54 \times 28}{18} = 10.27$ amps.

so that $i_1 + i_2 = 10.81$ amps.

Hence potential of positive outer
$= 10.27 \times 20 = 205.4$ volts above earth,
potential of negative outer
$= 10.81 \times 18 = 194.6$ volts below earth,
and potential of middle wire
$= 0.54 \times 10 = 5.4$ volts above earth.

These figures check with the voltage of 200 between the middle wire and each of the outers.

(To be continued.)

Finance.—The directors of the Rushden E.S. Co., Ltd., have declared an interim dividend of 3½ per cent. per annum, and the shareholders of the Northampton E.S. and P. Co., Ltd., are to receive an interim dividend of 4 per cent. per annum.

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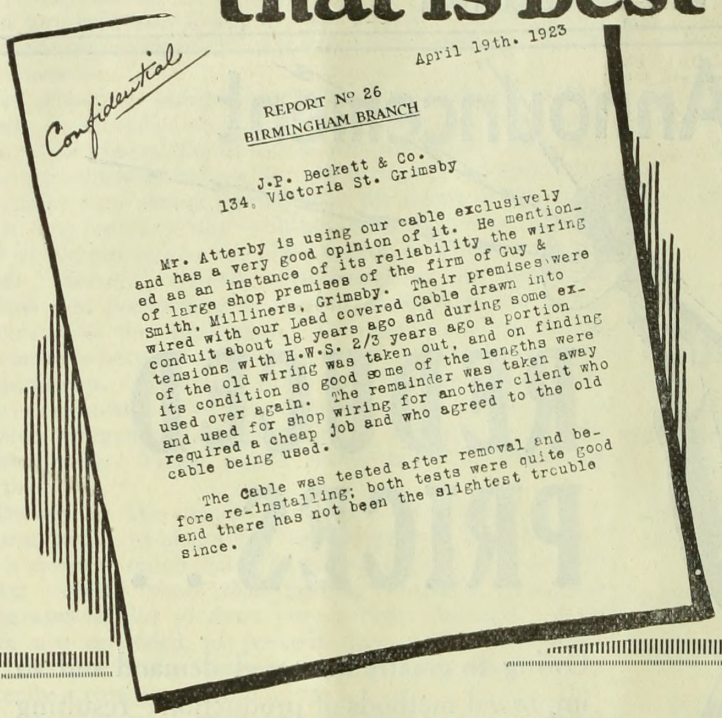
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A Confidential Report that is best made public-


Confidential

April 19th. 1923

REPORT No 26
BIRMINGHAM BRANCH

J.P. Beckett & Co.
134, Victoria St. Grimsby

Mr. Atterby is using our cable exclusively and has a very good opinion of it. He mentioned as an instance of its reliability the wiring of large shop premises of the firm of Guy & Smith, Milliners, Grimsby. Their premises were wired with our Lead covered Cable drawn into conduit about 18 years ago and during some extensions with H.W.S. 2/3 years ago a portion of the old wiring was taken out, and on finding its condition so good some of the lengths were used over again. The remainder was taken away and used for shop wiring for another client who required a cheap job and who agreed to the old cable being used.

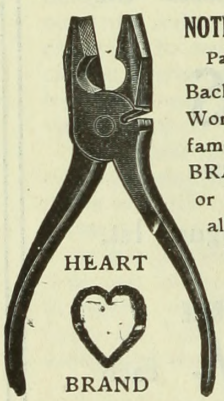
The cable was tested after removal and before re-installing; both tests were quite good and there has not been the slightest trouble since.

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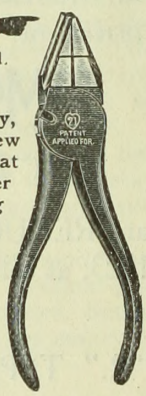


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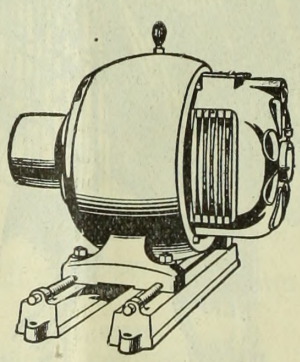
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TO OUR READERS.

ELECTRICITY is published every Friday, and, if ordered, is on sale at the principal Railway Station Bookstalls and Newsagents on that day. It has a very large sale throughout the United Kingdom, as well as in the British Colonies and Abroad.

New advertisements for the displayed columns and alterations to existing ones must reach the publishing office not later than first post Tuesday morning, in order to be in time for the issue of the following Friday. This is important. Rate quoted on application. Subscription: 13s. a year, 6s. 6d. half year, 3s. 3d. a quarter in advance, postage prepaid in the United Kingdom and abroad.

Questions to which an answer is required must be accompanied by a 1½d. stamp for reply. When considered of sufficient interest, the answer will probably appear in the paper.

All remittances payable to the Publishers, S. RENTELL AND CO., LTD., 36-39, Maiden Lane, London, W.C.2. Telephone No. 2460 Gerrard.

Current Topics.

The Life of V.I.R.

In view of the widely varying characteristics of vulcanised indiarubber as used for the purpose of insulating electrical conductors of the gauges commonly employed for wiring houses and buildings, it would be interesting to obtain some data, based on actual tests or practical experiences of the condition of some of the older installations wired with this class of conductor after having been in service for a number of years. Apart from obsolescence of fittings, switches, etc., and external deterioration due to handling of exposed portions of the installation, one would naturally assume that a wiring system of good quality and workmanship should last indefinitely since there is no actual wear and tear of either conductors or insulation. Unfortunately, however, indiarubber is a very unstable mixture of organic and inorganic materials which not only varies with age according to its composition, but also under the influence of light, heat, moisture and other external influences.

So far as the vulcanised compound itself is concerned I have inspected samples of V.I.R. years after manufacture which were still apparently in good elastic and presumably electrical condition. Other samples originally of higher megohmic grade, after the same period, have proved to be perished or oxidised and hardened right down to the copper, cracking with the least flexure, and it is fair to assume that such specimens, if subjected to a megger test, would not return any insulation value worth considering. What happens to samples of the original conductors is equally likely to happen to the complete wiring system which has been wired from the same coil or coils, and it is highly probable that many of the older V.I.R. installations would not bear inspection either on physical or electrical grounds. Should the system of compulsory periodical testing of installations referred to in these notes ever come into vogue it is probable that this question of the useful life of V.I.R. would assume considerable importance.

There is little doubt that the gradual decadence of conductor insulation is also controlled to a considerable extent by the mode of installation, whether in casing and capping, conduit or lead-covered; in fact, a considerable field for investigation is opened up by this possible and, in fact, probable deterioration of existing wiring installations. It would appear that a megger test, *per se*, is not sufficient to determine whether an old installation is still in good order, inasmuch as it may be materially affected by surface leakage at the various outlets and fittings and the net reading may not truly represent the condition of the actual conductor coating. The latter, if dry and undisturbed, may well show a high reading, although actually perished and a source of danger under certain conditions. Wherever there is any suspicion of the wiring itself having deteriorated the responsible contractor called in to advise should make a point of opening up the casing or conduit runs at one or two widely separated points and satisfying himself that the V.I.R. still retains a measure of its original elasticity.

Hotel Telephones.

In view of the excellent organisation in other respects of most of our larger and better known hotels, it is surprising that more attention is not paid to the telephone systems with which they are equipped. The practice nowadays in the largest hotels is to instal a private branch exchange with an instrument in every room and afford junction and trunk facilities to all parts through the medium of a local operator or operators. The system is convenient and invaluable if only it were logically worked and competent operators appointed to this important duty. In an hotel telephone service it is fair to assume that only outgoing calls will be put through, in the majority of cases, from the various bedrooms; an hotel visitor does not spend a great deal of time in his or her room, and the primary function of the telephone therein is either for communicating with the hotel staff or for convenient privacy in making local or trunk calls. There is little difficulty so far as this part of the service is concerned.

The weakness in regard to most hotel telephone systems has to do with calls incoming to guests. Unless a visitor is expecting a call and makes a point of being in his or her room or near the silence cabinets in the vestibule, he has to be paged, and this paging is done in a very perfunctory manner by boys who seldom use their reasoning powers to determine where a visitor is most likely to be at any given time. Coupled with this we often find the operating duties at the hotel switchboard relegated to one of the bookkeepers or young lady attendants who has multifarious other duties to attend to, and is consequently unable to concentrate on the very personal service required in efficient hotel telephoning. I had an experience, one of many, only the other day which will serve to illustrate my point.

I found a message awaiting me at my office requesting me to ring up a business acquaintance on an important matter immediately, as he was sailing next day for America. He had left the name of his hotel and the number of his room, together with an intimation that he would be within call during a certain period. I promptly rang up the hotel, a leading railway establishment, and asked for my man, giving also his room number. After an interval of over a minute, the operator at the hotel again asked me with whom I wished to speak; evidence that she had been interrupted meanwhile to attend to some other duty. I repeated my correspondent's name and number, heard her try to ring his bedroom telephone, and then ask the maid on that landing to go along to the room and ask him to answer his 'phone.

On the face of it this was an absurd thing to do. If the man *had* been in his room he would obviously have answered his telephone. The inference was, therefore, that he was not in his room, and, as the time of the

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call coincided with the hour at which the table d'hôte dinner was staged, it was fair to assume that he would be in the dining room. The operator *may* have paged him; on the other hand, I heard no sign of this being done, although her speaking key was apparently left closed as I could overhear other sounds in the hotel. In any event, after a five minutes' attempt I failed to secure my man, and as he had no time to write me until he gets to the other side, I am still wondering what he wanted to see me about. The moral of this is that hotel managements might with advantage seek to improve their telephone systems, which at present leave much to be desired. It is the element of intelligent personal and uninterrupted service which is apparently lacking.

Unemployment and Railway Electrification.

If the suggestions put forward for the relief of unemployment during the coming winter by the Industrial Group of the House of Commons are adopted there should be substantial progress made in the several projected schemes of electrification which have not yet emerged from the discussion stage. Among the schemes which it is urged should be proceeded with at the earliest possible date are the extension of the electrification of the L. and S.W. Railway, including electrification of the main line to Brighton; suburban electrification of the N.E.R. and the main line from York to Newcastle; electrification of the Midland Railway to Tilbury and Southend. Other schemes include the Glasgow suburban lines, those around Manchester, certain mineral routes in South Wales, and extensions of the London Tube Railways. In connection with the South Eastern section of the Southern Railway, orders have already been placed with the English Electric Co. for 508 motors of 300 h.p. and with the Metropolitan-Vickers Co. for the equipment of additional rolling-stock approximating to 127 trains. If this programme is adopted it will involve an expenditure of from 40 to 50 millions and find employment for many thousands at present out of a job.

Engineering at Olympia.

I note with much pleasure that quite a number of well known and enterprising electrical firms are exhibiting at the Shipping, Engineering and Machinery Exhibition which will be held at Olympia from August 31 to September 22. For instance, Messrs. Siemens Bros. and Co., Ltd., have taken a large space and so also have the Consolidated Pneumatic Tool Co., who hold such a high reputation for electric drills and electric tools generally. Others include Automatic and Electric Furnaces, Ltd., British Electric Vehicles, Ltd., the Cambridge and Paul Instrument Co., London Electric Firm, and a host of similar undertakings, so the Exhibition as a whole is certain to be of wide electrical interest. So much so indeed that on September 21 an official visit is to be made to it by the Institution of Electrical Engineers, and the fact that such a visit will be made should be a direct incentive to every electrical engineer to see the Exhibition during the time it is open.

Needless to say, the proprietors of this paper have taken a stand, and I can say on their behalf that they will extent a hearty welcome to every reader or would-be reader who calls at Stand No. 4, Row A. As usual, they will be showing a splendid assortment of books dealing with all the varied branches of engineering and electricity which are within the scope of the exhibits generally, and they hope they will have plenty of visitors. I shall refer to this subect again in an early issue.

Elektron.

Questions and Answers by Practical Men.

RULES.

Questions: *We invite our readers to send us questions, preferably on technical problems that have arisen in actual practice. Questions which we consider of sufficient interest to our readers will either be replied to under "Answers to Correspondents" or replies will be invited from our readers. One shilling will be paid for the question which we select for competitive replies in this column.*

Answers: *A fee of 10s. will be paid for the answer which we consider shows the greatest merit, and 5s. for the one we select as second best. In judging the replies, importance will be attached to clearness and conciseness, as well as accuracy. The Editor reserves the right to make no award, or to accept only one reply, if, in his opinion, the answers received do not possess sufficient merit. Competitors desiring the return of their manuscripts, if unaccepted, should enclose stamped addressed envelope.*

Write on one side of the paper only, and if diagrams are sent, draw them on a separate sheet of paper attached to the manuscript. Competitors may adopt a "nom de plume," but, both in the case of questions and answers, the competitor's real name and address must be sent with the manuscript as a guarantee of good faith. No correspondence will be entered into with regard to successful replies. The Editor's decision is final.

Commencing with Question No. 101, a Diploma of Merit will be awarded to the six competitors who win the first or second prize the most times during the next twelve months.

The words "Questions and Answers" or "Q" and "A" should be placed at the top left-hand corner of all letters intended for this column.

Question No. 165.

I hear that in America they have an instrument known as a foot-candle meter. What is this for, and how does it work?—"Wireman."

Question No. 166.

Can any reader give me details of a good electrical fire alarm system? I wish to instal it in a small workshop where the temperature is always varying owing to the intermittent use of a muffle furnace.—"Turner."

(*Replies to Questions Nos. 165 and 166 must be received not later than August 25, 1923.*)

Answers to Questions.

Question No. 160.

When looking through an old book on cable laying I came across the expression "cable should be taken from the drum and laid in a figure of eight upon the ground before being drawn into the duct." Can any reader tell me why this should be, because the book does not tell me why?—"Jointer."

Answers to Question No. 160.

The first prize (10s.) has been awarded to "Astatic" for the following reply:—

The method of laying main cables in the form of a figure eight is almost standard practice to-day, and it is usually employed where long lengths of cable have to be laid under difficult conditions. As a general rule main cables are laid under the supervision of the contractors, and the supply company's mains supervisor merely depends upon the maintenance guarantee of the specification, in addition to the final tests upon the cable, for the cable to be laid in a proper manner, hence the figure eight method of laying cables is not generally known.

The object of the method is to enable long lengths of cable to be laid without the possibility of a serious breakdown of insulation through careless handling. Years ago it was the practice of some cable manufacturers to store their cable in water tanks. The

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cable was "paid into" the tank, turn upon turn, so that when it was all in the tank it resembled a huge coil of wire. The ends were left out of the tank and the latter was filled with water. These were the conditions under which the cable was tested, and it was considered satisfactory.

So far so good, but when it was necessary to remove the cable from the tank it was found that it was not possible to do so without putting a twist in the cable each time a turn was laid off. This was, in effect, equal to twisting a cable after it was made, and it had a serious effect upon the insulation.

Let "Jointer" obtain a coil of ordinary 3/20 wire and try it for himself. Lay the coil upon the floor and pick up the free outside end of it. He will find that the wire will hang in the form of a spiral. It can then be understood that many twists would be placed in the wire if an attempt were made to lay it on the floor in one long length. Manufacturers were not slow to realise that this method of storing and testing cables was very injurious, especially when electricity began to be generated at fairly high voltages. They now, in a large number of cases, use the "figure eight" method. This is as follows:—We will presume that a long length of cable has to be laid. The same methods used when laying a short length cannot be adopted, that is, it cannot be paid off from the drum straight into the duct. This is because it is too heavy, and "man handling" is dangerous to insulation. One half of the cable is therefore "man handled" into the duct and the half is laid off the drum in the form of a figure of eight.

To do this a U-loop is taken back from the drum,

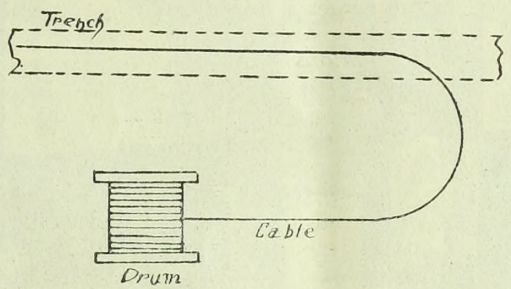


FIG. 1.

Fig. 1. One side of the loop is in the duct, the other side leads from the cable drum. The length of the loop should be as long as possible, but this will depend upon the space available. Assuming the length of the U to be 40 feet, the cable from the drum side should be crossed over the duct side as shown

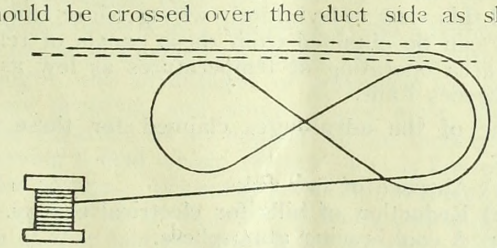


FIG. 2.

in Fig. 2, about 20 feet from the end of the U. The figure eight can then be completed and continued until the whole of the cable is paid off the drum. Then the end can be drawn in the duct in the opposite direction to the first half of the cable. If "Jointer" will again practice with a coil of 3/20 wire, this time fixing it as he would a cable drum, he will find that the "cable" can be drawn in the second half of the duct without any twists.—"ASTATIC."

The second prize (5s.) has been awarded to "Mains" for the following reply:—

The laying of cable upon the ground in the form of a figure eight preparatory to laying in a trench is known as one form of "flaking." But it is neither necessary nor desirable to adopt any method of flaking prior to drawing cable into a duct, as this operation can be carried out quite satisfactorily by drawing the cable directly off the drum mounted over the manhole in the usual manner.

However, flaking is often necessary when laying cable in a trench when the ground has to be opened up in two or more portions, or when the position of the obstructions, or weight of the cable, renders it inadvisable to attempt to handle the whole length of the cable in its entirety. In this event it will be necessary to pull the cable first in one direction into the trench, and then remove the remainder of the cable from the drum and lay it in a loop on the ground, afterwards pulling it into the trench in the opposite direction. This is another form of flaking, and it is only advisable to adopt this method when there is plenty of room, and the whole length of cable can be laid out in the form of a letter U.

In crowded thoroughfares it is often impossible to flake except by laying the cable in the form of a figure eight, and this can be successfully accomplished if the necessary precautions are taken. The loops should gradually increase in size in order that the only point at which the cable crosses back on itself is at the centre of the figure, and at this point sacks should be placed between the layers to prevent damage to the sheathing.

Flaking in any form is not advisable if it can possibly be avoided, and it is sometimes better to cut the cable and make an extra joint if at all possible.—"MAINS."

MORAL RESPONSIBILITIES—A PICTURE WITH TWO SIDES.

ONE SIDE.

That a man cannot do as he will with his own is a somewhat hard doctrine, but when once he enters business he ceases to be a free agent, for, no matter how clear the legal aspect may be, the moral responsibilities he incurs cannot be disregarded. The initial movement is quite voluntary, for he is not compelled to invest his money in any specific direction, but the consequences of that movement are so widespread that factors other than his own convenience must be taken into consideration.

He has, say, £20,000, and, being interested in engineering, he builds a factory in a small country town for the purpose of manufacturing a certain product. There being no other engineering factory in the immediate vicinity, he must needs import the skilled labour necessary for the start up of the business, but as time goes on, this labour is utilised for initiating the rustic into the mysteries of the factory.

The whole aspect of the place is changed. Strangers flock into the town, either to work in the factory or to take the place of those who have forsaken the

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plough for the assembling bench. New streets are made and houses built, more shops are opened to cope with the increasing demands, and the erstwhile sleepy agricultural town is transformed into a busy little industrial centre.

The boys of the place have new desires. No longer are they content to follow in father's footsteps on the farm or to be apprenticed to the local builder, but they must needs hanker after factory life. The spirit of unrest is upon them—they enter the factory, and their destiny is decided.

These changes have been brought about by the man with the money, and, when he ponders over the influence he has exerted, he must feel a sense of responsibility. Not from a legal standpoint, mayhap, for so long as he pays the union rate of wages and observes the rules and regulations imposed upon him by the Government he has nothing to fear.

But suppose that after a while he tires of the business, or the return is not so high as anticipated, is he justified in closing that factory? At first blush it would seem that the answer is in the affirmative. It is his money, certainly, and if that money had been left in the bank it could have been withdrawn almost at any time.

The question is, however, not so easily answered, for in the manner of his investment he has incurred responsibilities which cannot be ignored. Had the money remained in the bank, the withdrawal would have interested few outside banking circles; but, as he chose to invest in business, he must shoulder the obligations which business entails.

In like manner, too, the established company incurs responsibilities when it decides to extend, for more labour is attracted, and, glibly as we talk of "semi-skilled" labour and the opportunities offered, it must be remembered that these men are spoilt unless employment is continuous. The wholesale discharging of hands, therefore, has a demoralising effect, and the employer cannot escape liability unless he can prove that every effort has been made to keep the men fully employed.

No man can be allowed to effect drastic changes in the lives of people and still escape liability. Business is not a pastime, to be taken up and set down at will. It is a serious proposition, and the probable outcome should be well considered before the venture is decided upon.

Too many businesses do not pay because no real effort is made to make them pay. Too many are being run to-day on pre-war or war-time methods, and they are not likely to pay. Too many companies are thinking wholly and solely of wage cuts, without doing anything to stimulate business on their own account. Too many are waiting for customers, instead of getting after them.

The engineering industry has contributed too many to the ranks of the unemployed, simply because it has shaped men and women and made them unfit for other work. The mind must guide the hand, and lack of inclination is definite evidence of unfitness. The man with the money bewails the lack of dividends, and labour cries out for the work to which it has become accustomed.

Surely this state of affairs would never exist if each recognised his moral obligations, and made an effort to discharge them. If each would say "*I* am responsible," and work as though *he* were the only one liable, something would be achieved. Honest endeavour, even if unsuccessful, is better than grousing, and, if the employer will realise that he is a power, for good or for ill, he will prove his greatness by facing, instead of shirking, his moral responsibilities.

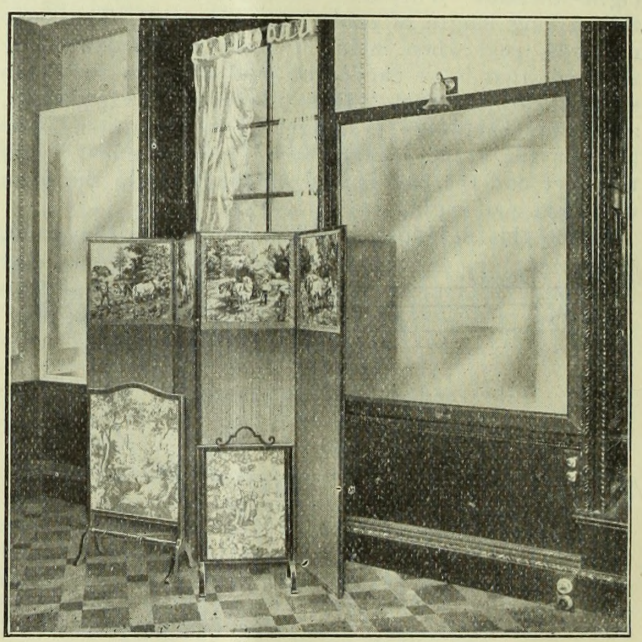
W. J. HISCOX.

An article on "The Other Side" will appear in next week's issue.

RADIANT WARMTH.

We have received a booklet from Messrs. Grierson, Ltd., 43, Bloomsbury Square, London, W.C.1, which describes a new method of warming by means of low temperature panels.

The radioelectric panels described and illustrated are certainly very novel and, we feel sure, will be appreciated in the home during the winter months. The general public and many technical engineers have up to the present time been under the impression that for all practical purposes the property of radiating heat



is confined to bodies operating at a high temperature. Research work carried out over a long period has proved this view to be entirely wrong, since remarkable effects can be obtained from these panels of relatively large area operating at temperatures as low as 90 to 100 degrees Fahr.

Some of the advantages claimed for these panels are:—

(1) Absence of fire risks.
(2) Reduction of bills for electrical energy.
(3) A cool bracing atmosphere.
(4) No maintenance costs owing to the absence of oxidisation at the low operating temperature of the elements.

It would appear from our experience of electric heaters of the past that the last clause is one that will be appreciated by the general public.

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SINGLE-PHASE COMMUTATOR MOTORS.

THEIR PROGRESS AND REASONS WHY THEY DEMAND THE ATTENTION OF POWER ENGINEERS.*

(*Continued from page* 377.)

Some purchasers, it is to be feared, still consider nothing but first cost in purchasing small electric motors, and it is, of course, still possible to get the squirrel-cage type of split-phase motor, now obsolete, a little cheaper than the more modern compensated type, though the difference is not very great, and to ignore the extremely low power factor of the machine. Such a policy is liable to be very heavily penalised in the future, owing to the supply authority adopting the k.v.a. basis of charging, when the user of the squirrel-cage motor will find his current bill increased, say, 20 per cent., above that of the user of the same horse-power in the form of a modern unity power-factor type of motor.

Fortunately, as the modern type of motor is about the same price as the slip-ring type of motor, there is no incentive to instal the latter.

We do not, of course, wish to maintain that single-phase distribution is to be preferred for large powers or where a dense distribution of motor load is to be found. On the contrary we regard it as the correct system for small towns or self-contained districts where no great density of motor applications is to be expected or where the chief load does not consist of motors. Such a single-phase system should preferably receive a bulk supply from a large polyphase system, the district supplied with single phase being sub-divided so that the total power supplied is fairly well balanced among the three phases, bulk three-phase supply being given to a local sub-station where it is sub-divided at a local switchboard.

As the power to be distributed becomes greater, the advantages of the single-phase enumerated above become less important, for instance:—

(1) The cost of wiring and auxiliary apparatus becomes less in proportion to that of the motor.

(2) The saving in the first cost due to using a large three-phase motor justifies a slightly greater expenditure on distribution. This saving is largely nullified, however, if a unity power-factor type of three-phase motor is installed. It is doubtful if a single-phase unity power-factor system is not quite as cheap as a polyphase system at reduced power factor even for large powers.

(3) Heavy power supply justifies high-tension transmission, which offsets the saving due to the simplicity of single-phase cable, etc.

Thus, while there is less difference in the advantages of single-phase and polyphase supply than has hitherto been thought, the advantages of polyphase for large powers are decisive, and single phase must consequently be regarded as an adjunct of the three-phase system having a field which, though wide, is limited to the smaller powers. Within its own field, as mentioned above, it is superior to all other systems, and with the extension of that field the system will extend. This is becoming remarkably evident at the present time where the small independent direct current systems of a large number of towns are being changed to single phase so as to permit of bulk supply without the installation of rotating apparatus in the sub-station. This is usually facilitated by the fact that single-phase mains are identical with D.C. mains. It is found that with single-phase supply cable faults are fewer than with direct currents, a figure of 1-5 having been mentioned to the writer. This is, of course, due to the absence of electrolysis on single phase.

It will be of interest now to give some particulars of the characteristics of up-to-date single-phase motors. A comparison of a compensated type machine with squirrel-cage single-phase induction motor of approximately equal efficiency shows:—

	Full load power factor.	Average load power factor.
Squirrel cage ...	77 per cent.	57 per cent.
Compensated type ...	100 per cent.	100 per cent.

A particularly noticable feature of the compensated motor is that it retains its high power factor down to quarter load, while the power factor of the induction type, though it may be fairly high at one particular load, falls off enormously directly we vary the load. The motors tested were four-pole machines, and the six-pole machine of the same rating in a larger frame has a somewhat higher efficiency.

It is a well-known fact that purchasers of motors usually order them of a greater horse-power than they really need. This is due to the fact that it is frequently impossible to gauge the horse-power required by the machine which the motor is to drive, and in estimating it a purchaser tends to err a good deal on the safe side. This tendency is still further emphasised with the split-phase motor, owing to its inherent starting troubles and poor overload capacity, hence the purchaser of this type of motor frequently orders a machine rated at least twice what the load requires, and thus, whatever may be the power factor of such a machine at full load, its power factor on the load on which it actually operates is very low indeed.

At half load it would not be more than 55 per cent. Induction motors, in fact, which give .8 power factor on full load rarely give more than .6 in day-to-day running.

The current taken by the split-phase type is 36 per cent. greater at full load and 82 per cent. at half load than the compensated type and a case which has very heavy currents taken by the former type of motor. In this case a customer had installed a split-phase motor and wired it up at considerable cost, allowing for only the same current as would be taken by a direct current motor. When installed, of course, the machine took very much more than its estimated current owing to its low power factor, and the wiring was totally rejected by the insurance inspector, and had to be replaced at about double the original cost. The whole of this expense could have been saved had a compensated type of motor been installed, taking very nearly the same current as a direct current machine.

(To be continued.)

* A Lecture delivered before the N.A.S.E., by F. Creedy, Esq., A.M.I.E.E., A.C.G.I.

Tenders Accepted.—The Siemens and English Electric Lamp Co., Ltd., have obtained the contract to supply 14,052 Siemens vacuum and gasfilled type train lighting lamps to the Bombay, Baroda and Central India Rly. An order has also been placed with them for four months' supply of incandescent electric lamps to the Southern Rly. Co.

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Various Items.

Motor Generators Wanted.—The P.M.G.'s Dept. at Sydney invite tenders for motor generators. Specification, etc., at the D.O.T. (Room 52), 35, Old Queen Street, London, S.W.1.

Fire.—Clients of Ebonestos Insulators, Ltd., will be pleased to hear that the recent fire did not in any way affect the company's moulds and moulding presses, and as they hope to have a temporary finishing department ready in a few days, production will not be seriously restricted.

Czecho-Slovakia.—The Report on the Industrial Situation in this important country has just been issued by H.M. Stationery Office, price 1s. 8d. post free. It contains much matter of interest to trading firms in this country, especially those associated with the import of glassware and shades, for which the former Bohemia was so celebrated. There is also a certain amount of information on the possibilities of trade for electrical manufacturing firms.

Business Opportunities.—The Town Council of Johannesburg has now voted in favour of the proposed new power station, the total cost of which will be about £500,000.—The Electrical Department of the N.S.W. Government Railways are inviting tenders for a frequency changer for the White Bay power house at Sydney. Particulars of both the above business propositions may be obtained from the D.O.T. (Room 52), 35, Old Queen Street, London, S.W.1.

London's Electricity Supply.—An interesting return has just been issued by the L.C.C. It deals with electricity supply in the London and Home Counties electricity district as determined by the Electricity Commissioners, and relates to the years 1920-21-22. The book, with maps, is published by Messrs. P. S. King and Son, and may be obtained from them or from ELECTRICITY Office, price 5s. 3d. post free. A review will appear in these columns in due course.

Austrian Marconi Company.—The Oesterreichische Marconi Aktien Gesellschaft (Austrian Marconi Co., Ltd.), which was formally constituted in Vienna on July 13, with a capital of £133,000, has registered offices at Renn Gasse 14, Vienna. The majority of the board and the entire staff are Austrians. The company has the sole right of carrying on radio-telegraphic services between Austria and other countries for a minimum period of 30 years, and the rates will be the same as for ordinary telegrams. Several new stations will be opened for traffic before the end of the year.

Telephone Development.—Iowa, U.S.A., has the highest telephone development in the world. This single State has as many telephones as all of France, and more telephones than any other foreign country except only Germany, Great Britain and Canada. It has more telephones than Italy, Belgium, Austria and Switzerland combined. It has as many telephones as there are in the whole of Asia, including Japan. It has twice as many telephones as there are in the whole of Australia. The city of Des Moines has more telephones than any city in Great Britain, except only London, Glasgow, Liverpool and Manchester. The population of Des Moines, as shown by the last census, was approximately 140,000. Belfast, with about three times its population, has one-quarter as many telephones. Birmingham, with more than eight times its population, has about three-quarters as many telephones. Edinburgh, with almost exactly three times its population, has about one-half as many telephones.

U.S. Govt. Specification for Dry Cells.—Specifications for various types of dry cells have been issued by the United States Bureau of Standards as Circular No. 139. These specifications were officially adopted by the Federal Specifications Board, June 15, 1923, for the use of the departments and independent establishments of the U.S. Government in the purchase of dry cells. The specifications are issued by the Superintendent of Documents, Government Printing Office, Washington, D.C., and copies can be ordered from Messrs. S. Rentell and Co., Ltd. (ELECTRICITY Office), at 1s. 1d. each post free.

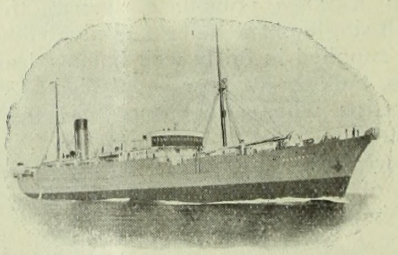
Exhibitors Form an Association.—As a result of the meeting held at the Cannon Street Hotel on June 28, 1923, it was unanimously agreed to form the "Association of British Exhibitors." A provisional committee was elected, comprising representatives of some of the most important exhibitors in the United Kingdom. Articles of Association are now being drawn up, and the committee are anxious to put into the hands of all who exhibit full particulars of the aims and objects of the Association. The provisional secretary is Mr. E. C. Balmforth, Association of British Exhibitors, 69, Victoria Street, London, S.W.1.

Motor Wanted.—An advertiser wants a 250 h.p. A.C. motor. For details, see a prepaid advertisement.

Healthy Optimism.—Mr. Sidney R. Lowcock, consulting engineer to the Office of Works, Post Office and India Office, distributing the certificates on July 25 to the students of the Crystal Palace School of Engineering, said at the present time engineering was not good. People who made a lot of money during the war appeared to have spent it. But there was an enormous amount of engineering work to be done, and the prospects of engineering within two years were good.

THE NEW *FARADAY*.

On Monday, July 23, various representatives of the technical Press were courteously invited by Messrs. Siemens Bros. and Co., Ltd., to visit their works at Woolwich, and, after inspecting the various processes of making the submarine cables for which the firm hold such a world-wide reputation, we were taken on board the new vessel and invited to inspect the actual process of taking the cable on board. We were then shown all over what is undoubtedly one of the finest vessels of her class afloat, and our grateful thanks are due to the officers of the company, both technical and marine, for the way in which they explained the machinery and work associated with submarine cable laying and repairing. The cable now being loaded on board is 1,000 miles in length, to be laid for the Commercial Cable Co. between New York and Fox Bay, Nova Scotia, the total weight being about 4,000 tons. It is of a specially heavy type, designed for fast working, and is insulated with gutta-percha, the



weight of the copper conductor being 450 lb. per nautical mile. The armouring is of eight different types, this being rendered necessary by the varying depths of water between the points to be connected, and also to the fact that a large portion of the route is over fishing ground, where the cable is liable to be disturbed by ships' anchors, etc. During the process of manufacture, the cable and all its component materials have been rigorously tested and passed by the Cable Company's engineers.

The new *Faraday*, which was built at Jarrow by Messrs. Palmer, is the second cable ship of this name to be owned by Messrs. Siemens, and is one of the largest and most modern vessels of her type afloat, and has been designed to carry about 4,500 tons of cable. She has a steaming radius of 10,000 miles, and is fully equipped with the latest appliances for laying and repairing cables.

At the luncheon on board, which followed the inspection, the chair was taken by Sir William Bull, M.P., a director of the company, and all present joined most heartily in wishing success to the new ship and plenty of work to Messrs. Siemens. Not a few of us wished we were going for a voyage in her. The cabins looked so cosy, and everything was so comfortably arranged with a view to real efficiency.

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THE SOUTHAMPTON AUTOMATIC TELEPHONE EXCHANGE.

The new automatic telephone exchange at Southampton, which has been installed for the postal authorities by Messrs. Siemens Bros. and Co., Ltd., was duly opened to the public on June 30 last, and we are confident that the following brief description of the new plant will interest many of our readers:—

It was in the year 1886 that a public telephone service was first introduced in Southampton by the Western Counties and South Wales Telephone Company, the equipment being installed in a room at 150, High Street. By 1890 the system had grown considerably, and the subscribers were accommodated on a 200-line multiple switchboard in premises at the corner of Orchard Lane and East Street. During the year 1892 the undertaking was amalgamated with the National Telephone Company. The 200-line switchboard was very soon outgrown, and early in 1894 the exchange—which then had 300 subscribers' lines—was transferred to Hanover Buildings. The year 1897 saw the first underground telephone cables laid in the Southampton district, and by January, 1902, the number of subscribers had increased to 790.

The present magneto exchange was installed and inaugurated in the year 1902 in the specially designed telephone building in Ogle Road. The automatic plant is accommodated in the same building as the magneto exchange, which it will supersede.

The number of subscribers' lines reached the 1,000 mark in 1905, and by January 1, 1912, when the National Telephone Company's system was taken over by the Post Office, this number had increased to 1,620. By 1920 the number of lines had reached 2,000. The new automatic exchange provides equipment for 3,150 subscribers' lines, a good surplus having been allowed for future development, and it may now be regarded as inevitable that the automatic telephone system will in time entirely supersede the manual system. The advantages offered by the automatic system over the manual system are too obvious to need any emphasis here. We will, therefore, proceed with the actual description of the plant and apparatus installed in the new exchange.

Subscribers' Instruments.

The subscribers' instruments are of the standard central battery type fitted with a dial. A unique feature of Siemens Brothers and Co.'s dial is the arrangement which ensures that a definite pause is always made between the release of the finger plate and the commencement of the impulses. By this means the selecting switches are allowed ample time to perform their searching function, so that it is impossible for the subscriber to cause any train of impulses to be transmitted before the automatic switches are ready to receive them.

Preselectors.

Preselectors are simple rotary switches used for extending the subscribers' lines to the selecting switches. They were introduced originally by Siemens, and until a short time ago were an exclusive feature of the Siemens system. They are operated by interrupted current at a speed of 50 steps per second.

The reliability of the Siemens preselectors has been strikingly demonstrated at the 1,300-line automatic exchange installed by the company at Grimsby, where only four preselector faults occurred during the second year's working, and none at all during the third year's working.

Selectors.

The selector switches have vertical as well as rotary motion. The action of each switch is controlled by a set of relays which repeat the impulses transmitted over the subscriber's line.

The rotary action of *first* and *second* selectors is automatic. With *final* selectors the rotary action is controlled by the last train of impulses sent by the subscriber's dial, except for calls to P.B.X. lines, in which case the final selector searches for a free line if the directory number is engaged.

Motor Interrupter Machines.

Motor interrupter machines are provided to interrupt the current for driving the automatic switches. They are run from the exchange battery. Each machine has a number of cam-operated contacts. These contacts are alternately opened and closed at the speeds required for driving the various switches, namely, 50 per second for preselectors, 25 per second for the rotary magnets of selectors, and 10 per second for the rotary magnets of the P.B.X. final selectors.

General.

Certain parts of the exchange equipment are of the standard types used on C.B. manual exchanges, and it is therefore unnecessary to describe them in detail. These comprise the main distributing frame of 47 verticals, the intermediate distributing frame of 36 verticals, and the subscribers' meter rack of 7 bays.

All the automatic apparatus is mounted on open racks of uniform height, easy access to the apparatus being obtained from one side of the rack, and to the wiring from the other side. All switch racks are provided with guard rails, and the feet supporting the racks have been designed to allow of a clear run for sweeping and cleaning. The use of base angles has been avoided, as these make cleaning difficult and provide corners for the accumulation of dirt.

The relays controlling the automatic switches are mounted immediately above the switches with which they are associated.

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Each automatic switch rack is provided with a miscellaneous panel arranged to accommodate the relays for the alarm circuits, and other apparatus common to the rack. Terminal strips are provided at the left-hand end of each panel of switches for terminating the incoming lines or links. On the selector racks terminal strips are provided at the right-hand end of each panel for terminating the outgoing lines or links.

Alarm type fuses are accommodated on the automatic switch racks for all preselector and selector circuits. They are fitted on small slate bases at the left-hand side of each panel on selector racks, and in the miscellaneous panel on preselector racks.

PRESELECTOR RACKS.

There are 34 first preselector racks and 5 second preselector racks. Each rack has accommodation for 100 preselectors, which, together with their associated relays, are mounted in panels of ten.

The contact banks in a panel of preselectors are multiplied together by means of bare wire commoning usually referred to as "piano wiring."

FIRST SELECTOR RACKS.

There are 11 first selector racks, each of which has a capacity for three panels of ten switches.

Dialling-in first selectors are provided to enable the operators at a large number of the surrounding manual exchanges to obtain Southampton subscribers by direct dialling over the junctions which terminate on these selectors. Among the exchanges which will obtain direct connection by dialling over the trunk lines are Andover, Bournemouth, Cowes, Salisbury and Winchester.

SECOND SELECTOR RACKS.

Ten second selector racks are provided. Each rack accommodates four panels of ten switches, instead of three panels as on the first selector racks. The second selector panels are not as wide as those of the first selector racks, as only four relays are required to control each switch.

The equipment of second selector racks is in general similar to that of the first selector racks.

FINAL SELECTOR RACKS.

The 12 final selector racks are similar to the first selector racks, but they provide accommodation for 15 switches in each panel instead of 10.

P.B.X. final selectors have two additional relays mounted above the usual set of eight relays required for ordinary final selectors.

LINK DISTRIBUTING FRAME.

This frame has been developed with the object of providing, in a compact form, all the facilities necessary for making changes in the grouping of switches when traffic conditions vary. The upper portion of the link distributing frame accommodates terminal strips for terminating the links from each panel of first selectors. The lower portion accommodates terminal strips which are cabled to the second selector switches or to other outgoing circuits served from first selector levels. Cross-connections, or jumpers, run between the upper and lower portions of the frame, serve to connect the first selector banks to the second selector switches.

The terminal strips used are of a special design which allows cable and jumper wire to be terminated on the same tags. They are so arranged that the concentration of links can be effected by means of bare wire commons. This method enables the inter-connecting of the various ranks of switches to be seen at a glance by inspection of the commons. Any desired alteration of the existing grouping can easily be made without disturbing the permanent cabling, simply by removing or rearranging the bare wire commons and cross-connections. The frame consists of separate units of the same height as the automatic switch racks, the units being lined up together to form one complete distributing frame.

POWER PLANT.

The exchange is operated on the common battery principle. Duplicate sets of 60-volt batteries of the Tudor Accumulator Co.'s make are provided. Each battery consists of 30 cells having boxes capable of accommodating plates for a capacity of 1,353 ampere-hours, but at present fitted with plates giving a capacity of 904 ampere-hours.

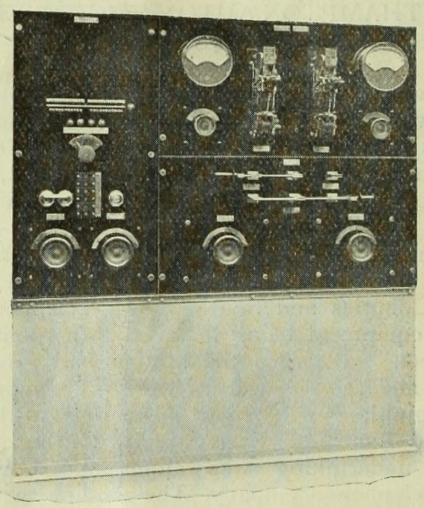


FIG. 1.—POWER BOARD.

As the automatic apparatus operates correctly at any voltage between 54 and 66 volts, no voltage regulation or voltage alarm devices are required to maintain the satisfactory working of the exchange.

The only auxiliary battery needed is that required to enable the subscribers' P.B.X. switchboards to be supplied with power at the correct voltage. This consists of a 13-cell counter E.M.F. battery, also of the Tudor Co.'s manufacture.

Two motor-generator charging sets are installed. They are of the English Electric Co.'s manufacture. Both sets are driven from the public supply mains at a pressure of 400 volts D.C. Each machine has a normal output of 8.5 kw.

Two ringing dynamotors, made by Messrs. Crompton and Co., are provided. One of these machines is driven from the 200-volt D.C. supply mains, and the other from the exchange battery. Interrupter attachments are fitted on each machine to interrupt the current for the various tone and alarm signals.

MOTOR INTERRUPTER RACKS.

Two of these racks are provided. Each rack is equipped with duplicate motor interrupter machines,

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switches, fuses and other equipment associated with the driving circuits. These racks also accommodate the distribution fuses which are inserted in the leads between the battery and the various groups of automatic apparatus racks.

POWER BOARD.

The power board (Fig. 1) is the first of its kind to be installed in any large exchange in this country. It is provided with single-pole switches for all connections excepting those to the public supply mains. By this means the arrangement of the apparatus and wiring is simplified, and the general appearance of the power board considerably improved.

TEST DESK.

This new design of test desk (Fig. 2) was recently developed by Siemens Brothers and Co., Ltd., in conjunction with the engineers of the Post Office, and is being introduced for the first time at Southampton. It has now been adopted by the Post Office as standard

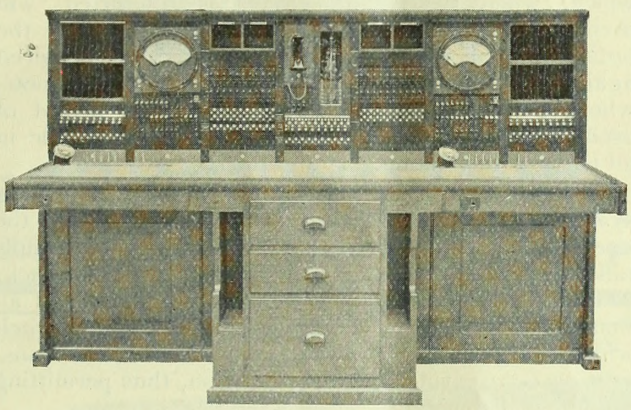


FIG. 2.—TEST DESK.

for future manual and automatic exchanges. The desk is built up in sections in a similar manner to that followed in a manual switchboard. It is thus readily extensible, and provides particularly good access to all apparatus both at front and rear. Two types of section are used—a two-panel testing section and a three-panel filing section. End-panels are provided to close in the sections at each end of the desk.

ELECTRICALLY OPERATED WATER VALVES.

(FROM A SPECIAL CORRESPONDENT.)

As is well known, the valves largely used in connection with water power are of such enormous dimensions that mechanical operation is essential, and in this connection electrical methods are coming more and more into favour, especially since operation from some central and convenient position at almost any distance can easily be arranged. One of the most interesting and valuable of the papers read at the recent annual meeting of the Institution of Mechanical Engineers in Glasgow was that by Mr. E. Bruce Ball, of Kilmarnock, entitled "The Storage and Handling of Water," which included a detailed description of the latest modern developments in gigantic mechanically operated valves, as well as weirs, shutters, gates and sluices. The paper was rendered particularly interesting because of the description given of many of the largest installations in the world, and a striking feature is the amount and quality of the work that has been undertaken in this field by the pioneer firm of Messrs. Glenfield and Kennedy, Ltd., of Kilmarnock, such as the great Vaal River barrage in South Africa, the Badlapur barrage in Bombay, and the Tata hydro electric power scheme in the Bombay Presidency. In this latter installation, the huge valves are of the throttle type, electrically operated, being actually 72 in. diameter bore with cast-steel bodies, gun-metal lined, and doors operating under a pressure of 600 ft. head of water. The valves are so arranged to work under "pressure equilibrium" at all times, whether for opening or closing, by by-passing across the door when opening and closing other valves in the system before operating the large valves. The electrical portion is a self-contained 1 h.p. A.C. motor operating through worms and worm-wheels with machine-cut gearing having a total reduction ratio of 3,564 : 1, the total time of operation being only one minute, another striking example of the convenience and efficiency of electricity.

MORAL RESPONSIBILITIES—A PICTURE WITH TWO SIDES.

THE OTHER SIDE.

(See page 411 for previous article.)

One side of the picture has been portrayed, but there is another side equally important, for this concerns the working man and woman! And, if it has been established that the employer has responsibilities he is morally bound to shoulder, it is a fact that, in this respect, the worker is no less liable.

The worker offers his labour for a wage, and he must keep his part of the bargain. The wage may not be all that he desires, but it is up to him to prove that he is worth more. Deeds, and not words, are wanted; for, although the word may secure the job, it is the deed which enables him to keep it.

Every person has the right to live, and, as money is necessary to purchase the essentials, the opportunity to earn must be given. For this purpose the minimum wage was established, this ensuring a modest wage for a modest effort. Beyond this it is a question of merit, and this it is which determines the value of the worker. No one gains by the modest return for the modest wage, and the worker is morally bound to make the first move. He has the job, and he must prove his worth—in short, he must show a margin of profit. Not until he has done this is he justified in asking for a higher wage, and it is because this truism is not generally appreciated that many industrial troubles are occasioned.

Just as the worker must be protected from the unscrupulous employer, so must the employer be protected from the unscrupulous employee. The war which is constantly being waged between the employers' and workers' organisations is absolutely unproductive, and the real solution lies in the determination of the respective organisations to recognise their moral (as well as their legal) responsibilities: to insist upon a square deal, and to expel the wastrels from their ranks. What a fine thing it would be to know that trade union membership denoted an honest and conscientious worker,

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and that membership of an employers' federation was proof of integrity and consideration.

The workers' organisations are, in the main, out to help the bottom dog, but they fail to understand that often this "dog" is at the bottom because he lacks the energy to climb. Some "dogs" will not walk unless they are pushed, and, if food is placed under their noses, and they are wheeled about in a bath-chair, can it be wondered that they lack incentive and are quite content with their lot?

Yet this is what is happening, and the employer is too often saddled with incompetents who make no effort to do better. It is true that ability is not evenly distributed—that health, strength and mentality are factors to be taken into consideration; but effort can always be recognised and appreciated, even though it be not crowned with success.

To look after those who are really incapable of helping themselves—to assist those to rise who have fallen—this is the duty of us all; but to retard the efforts of the many who would rise by their own exertions in order to lift up the few "won't rise and don't dies" is an act calculated to lower rather than to raise the standard of living.

It may be said that the employer has the remedy in his own hands, but if he discharges the "won't works," the cry of "victimisation" is speedily raised, and his shops are denuded of labour as a consequence. He may decide to adopt this course, and he may succeed in obtaining fresh labour; but how does he know that the change will be to his advantage? There may be just as many "won't works" in the new batch as in the old.

The employer cannot be expected to shoulder the whole of the responsibility, and part of it must devolve upon the shoulders of the worker. If a man invests in a business, he expects to get a return, and he employs labour to make this possible. If labour does not do its part he cannot be blamed if he decides to quit, for, after all, there are easier ways of throwing money away.

We are so hedged in with legal responsibilities and liabilities that we are apt to look upon them as the beginning and the end of all things. But all the legal enactments which operate cannot eliminate moral responsibility, and recognition of this will save us from the further incursions of the legal variety.

The worker has a family, which he is legally bound to maintain, but he is a poor head if he is satisfied with this. He is morally bound to do his best for his family, and he is failing in this respect if he remains upon a low level in order to maintain someone who can, but will not maintain himself. He can help the "bottom dog" to help himself, so that he may become a useful member of the community, instead of remaining an encumbrance.

Every worker is morally bound to put his best into the job, just as every employer is morally bound to remunerate the worker in accordance with his value. The higher the worker gets above the minimum wage line the more valuable he becomes, and this is direct proof that he recognises his moral responsibilities, and is prepared to shoulder them.

W. J. Hiscox.

WORLD'S LONGEST GUIDED RADIO TELEPHONE AND TELEGRAPH.*

The Pacific Gas and Electric Company recently placed in operation the "World's longest-guided radio telephone and telegraph system" between the Vaca-Dixon sub-station and Pit River power house No. 1, a distance of 202 miles. This system utilises the twin circuit, 220,000-volt transmission lines between the two points for a conducting medium, a total distance of 202 miles, and will be for the sole purpose of directing the operation of the two stations, both under normal and emergency conditions.

The receiving equipment consists of a universal receiver which has been modified to make it a non-regenerative receiver, and a loud-speaking outfit using two stages of audio-frequency amplification.

One of the new and unusual features is the unique method of calling. This is accomplished by mounting a calling microphone in the horn of the loud-speaker which, when the calling circuit is completed, will oscillate and howl in much the same manner that the ordinary telephone will howl when the receiver is placed against the transmitter. This gives a very loud note, whose pitch will depend upon the natural period of oscillation of the diaphragms and is clearly audible in all parts of the station.

Ordinarily, it is not necessary to use the calling system as the receivers are always in service and the operator near the set, so that the loud-speaker simply talks at him and he starts up his set and talks back. The system is arranged for simplex operation and all that is necessary is to operate a small telephone switch which energises a contactor to connect either the transmitting or receiving set to the antenna, thus permitting talking or listening.

The system is coupled to the transmission line through a single-wire antenna about 1,800 feet long. This wire is attached to the twin vertical circuit transmission towers at a point on the centre line of the tower and at the elevation of the middle cross-arm. Six suspension insulator units are used for dead-ending and supporting the antenna. The main station ground system is also used as a ground for the radio equipment.

The transmitting equipment is the vacuum tube telephone transmission equipment similar to that used by the high-powered broadcasting stations. Four 250-watt and one 50-watt Radio Corp. of America radiotron tubes are employed, two of the tubes being used as oscillators and two as modulators with the 50-watt tube as a speech amplifier.

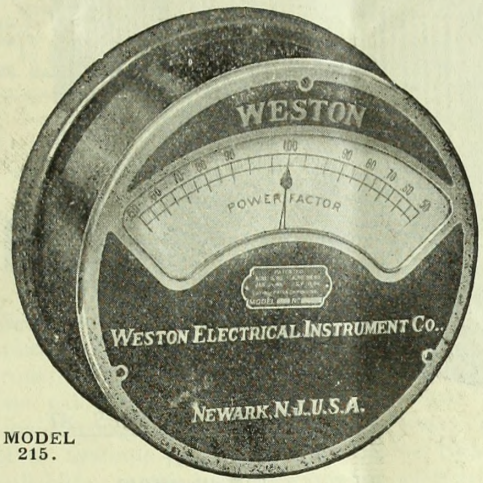
The engineers of the company have no doubt as to its dependability even with one of the 220 kv. lines down and grounded. They expect to effect communication between the stations under conditions when the wire lines will be out of service.

All of the experimenting and development work necessary to place the equipment in a satisfactory operating condition was done under the direction and supervision of Dr. L. F. Fuller, one of the foremost authorities in the field of radio activity.

* *Telephony*, Chicago.

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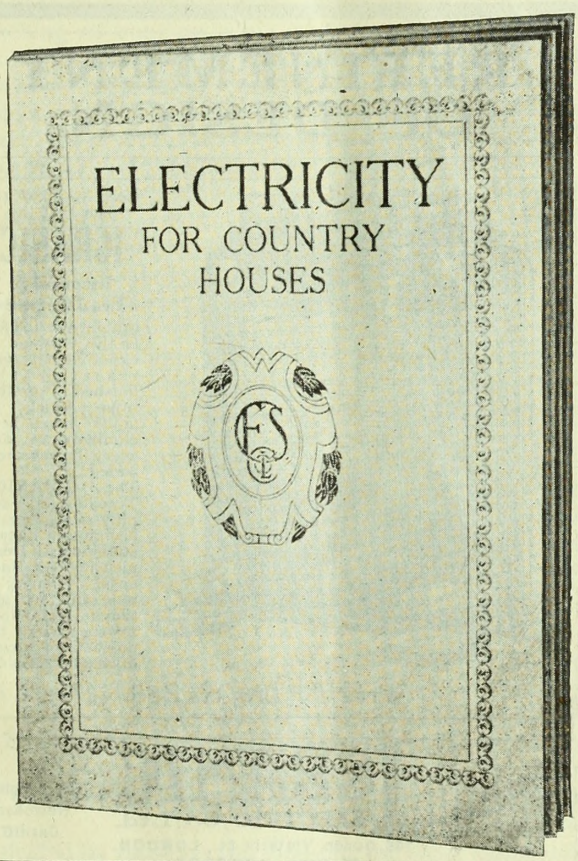
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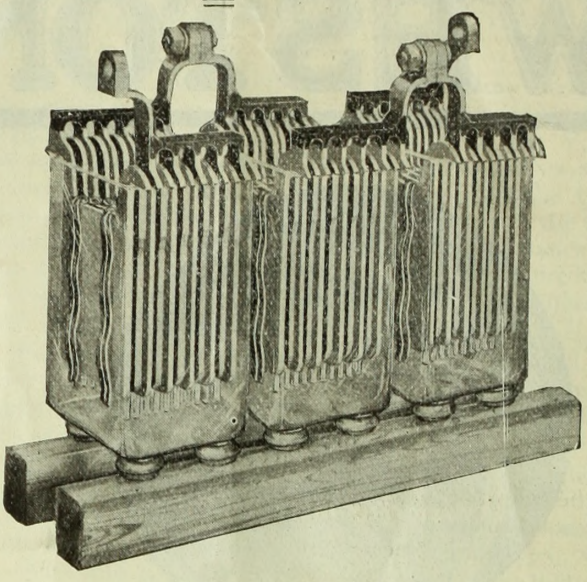
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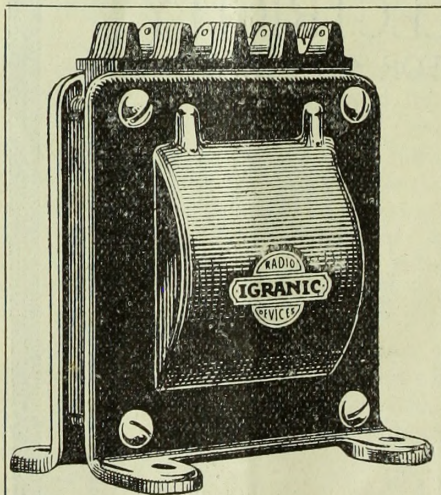
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TO OUR READERS.

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New advertisements for the displayed columns and alterations to existing ones must reach the publishing office not later than first post Tuesday morning, in order to be in time for the issue of the following Friday. This is important. Rate quoted on application. Subscription: 13s. a year, 6s. 6d. half year, 3s. 3d. a quarter in advance, postage prepaid in the United Kingdom and abroad.

Questions to which an answer is required must be accompanied by a 1½d. stamp for reply. When considered of sufficient interest, the answer will probably appear in the paper.

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Current Topics.

Tram Control.

The latest development of selective telephones to the control of one section of the L.C.C. tramway traffic is really a case of applying in a modified degree a telephone control system which has long been in use on the railways. Centralised control, with telephonic communication to various points along the several controlled routes, seems a very obvious system to adopt, one calculated to considerably increase the efficiency, time-keeping and passenger-carrying capacity over other systems which do not possess this facility but still cling to the long obsolescent system of travelling inspectors, who, instead of performing their true function of controlling and directing the traffic, spend most of their time examining the tickets issued to passengers. A great deal of the trouble and overcrowding practised on the tramways in some of our larger cities could be avoided by a properly organised control system.

Such a scheme, with a controller always in telephonic touch from a given centre, would do away with the bunching of cars on some routes, the failure to leave termini at scheduled time, and much unnecessary starting and stopping of cars due to the present chaotic system which leaves the sole control of every tramcar in the hands of its driver and conductor, regardless of what other cars are doing along the same route. Thus we constantly experience a loaded car crawling along on first speed for half a mile or so to the next "clocking on" station, and, as soon as its conductor has signalled his car at that station, a mad dash along the next section of the route at top speed to gain a minute or two in hand for the next registration. Obviously tramcars following a permanent way, should, like the trains they resemble, be amenable to the control of an individual or staff of individuals with convenient facilities for viewing the traffic conditions at any point far wider than either the driver or conductor of the car can possibly have. I look forward to a rapid development of the telephone control system for tramway traffic; it would at least help to remove a few of the disabilities under which this form of passenger transport labours at the present time.

Electrically-Driven Conveyors.

An interesting article in a Cardiff daily on the subject of belt conveyors served to direct my attention to the fact that the greater development of the electrically-driven conveyor system to the movement of large quantities of almost any material is a field which has been somewhat neglected by those on the look-out for fresh applications of electric power. The conveyor system of transporting coal, grain, ashes and such-like bulk materials is already familiar in the coal fields, among millers, and at the docks, but in the last named the conveyor principle might profitably displace a good deal of the existing hydraulic lifting and truck tilting tackle now so generally employed for loading ships. As the writer of the article points out, generally speaking, hydraulic hoisting tackle consumes far more power for the work done than electrically driven gear of the conveyor type, and when it is remembered that several tons of truck have to be lifted for every eight or ten tons of coal shipped, the latent possibilities of reducing the cost of shipping coal as well as of other bulk commodities become more apparent.

Electrically-driven conveyors which obviate the necessity for hoisting anything but the actual material, and which enable this latter operation to be performed at greater speed and less cost, are undoubtedly worth the closer attention of those responsible for modern dock and warehousing costs. The fundamental principle of moving material in a continuous and steady stream, rather than in a more or less regular series of bulky parcels representing truck loads, has obvious advantages and is one which with a little forethought can be applied to numerous classes of material in addition to coal, grain, etc. It has already been applied to the transport of human freight in the escalators or moving stairways familiar to those who make use of the London tubes, and he would be a bold man who disbelieved the possibility of this principle being still further extended in the none too distant future to moving side-walks in some of our busy city streets.

A steady and well distributed load is obviously easier to handle from an engineering point of view than the same load divided up into irregular batches of widely varying weight and size, as represented by the passenger load of a 'bus or tramcar. The belt conveyor principle for inanimate material should certainly be more widely developed, for here the initial problems have already been solved, and the system has proved its possibilities by actual trial, whilst conveyors of this type can now be constructed to suit any class of material or for any reasonable length of travel. It is in the electrical equipment of these conveyors that the electrical engineer should play his part by designing suitable motors, control gear, etc., for the still more efficient driving of this transport mechanism. From the conveyance of goods and materials to the transport of passengers is not a very big step, and the experience gained with conveyor development will assist in furthering the adaptation of the principle to the solution of some of our more pressing transport problems in densely populated areas.

Broadcasting Domestic Electricity.

Although there is at present, and very rightly so, a ban on the use of our broadcasting stations for general advertising of specific goods, there is no such embargo on the use of the new pastime for propaganda, and in this connection a very interesting address on electricity in the home was recently broadcasted from the London station of the B.B.C. by Mr. Stanley J. Harding, editor of the *British*

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Engineer's Home and Export Journal. Couched in homely phraseology, this brief but interesting discourse must have brought home to many housewives, listening-in on that occasion, the manifold advantages of electric service in the household and its labour-saving qualities. It was a truly excellent piece of propaganda by the E.D.A., and upon which they are to be congratulated. It supplements, but does not displace, the vigorous and extensive Press campaign which that association has been, and is still, conducting for the purpose of educating the public in the more widespread use of electricity in the home.

Broadcasting reaches a wider and different public to that which takes the trouble to read the various articles on domestic electricity which appear in their favourite dailies, and if the experiment can be repeated at appropriate intervals it will doubtless win over many converts to the cause of domestic electric service. There is still far too limited a use of electricity in the average household, and an enormous field to be tapped before we can fairly claim to have booked all possible or likely consumers in those districts where surplus power is available, and with the development in generating facilities now proceeding under the ægis of the Electricity Commissioners we shall want all the new consumers we can win over. Broadcasting affords a highly convenient and efficient means of educating thousands of potential electricity consumers.

ELEKTRON.

ELECTRICAL ENGINEERING—FINAL GRADE.

SOLUTIONS TO 1923 EXAMINATION QUESTIONS OF THE CITY AND GUILDS INSTITUTE.

BY EDWARD HUGHES, B.Sc. (Eng.) A.M.I.E.E.

(*Continued from page* 406).

Q. 3.—Why is it so much simpler to obtain inherent automatic voltage regulation in a dynamo than in an alternator?

Find how many series turns per pole are needed on a 500 kW. compound-wound dynamo required to give 500 volts at no-load and 550 volts at full load, the requisite ampere-turns per pole being 7,900 and 11,200 respectively. The shunt winding is designed to give 500 volts at no-load when its temperature is 20°C. The final temperature is 60°C.

A. 3.—The reasons why it is easier to obtain inherent automatic voltage regulation in a D.C. generator than in an alternator are :—

(*a*) The excitation, being in each case produced by direct current, requires in the case of an alternator that the load current should control the alternator flux either by altering the field of the exciter or by altering the field of the alternator directly. Such methods involve the use of a rectifier, or a special magnetic circuit, or an external regulator of the Tirrill pattern, etc., any one of which is much more complicated than the simple addition of series turns as in the D.C. compound generator.

(*b*) Since the regulation of an alternator depends upon the power factor of the load, any method depending only upon the variation of load *current* gives the desired automatic voltage regulation only when the P.F. remains constant at a definite value. In the Tirrill regulator, for instance, the effect of P.F. is allowed for by having a pressure coil as well as a current coil for controlling the operation of the mechanism.

The P.F. of a D.C. supply is always unity, and therefore its effect does not have to be considered in the operation of D.C. machines.

The second part of this question is very loosely worded, and it is difficult to know what the examiners require. When a dynamo has to over-compound from, say, 500 v. at no load (N.L.) to 550 v. on full load (F.L.), this requirement has to be fulfilled under normal working conditions, namely, when the machine is at a steady temperature. If a shunt winding is designed to give 500 v. at N.L. when its temperature is 20°C., then at a temperature of 60°C. its resistance will be $R_{20} \times \{1+0.004\times 40\}$, namely, 1.16 times its resistance at 20°C., and the N.L. voltage may by then have decreased to any value depending upon the point of the magnetisation curve at which the machine is designed to work when giving 500 v. N.L. A compound dynamo is invariably fitted with a shunt regulator to compensate for the variation of resistance of the shunt winding, and the latter is designed to give the N.L. voltage after it has attained a steady temperature. We shall therefore assume these conditions in working out this calculation.

Amp. turns per pole required at 500 v. N.L. = 7,900

Amp. turns per pole required at 550 v. F.L. = 11,200

Amp. turns per pole supplied by the shunt winding at 550 v. $= 7{,}900 \times \frac{550}{500}$

$= 8{,}690$

$\therefore$ Amp. turns per pole to be supplied by series winding $= 11{,}200 - 8{,}690$

$= 2{,}510$

But full-load current $= \frac{500 \times 1{,}000}{550}$

$= 909$ amps.

$\therefore$ No. of series turns per pole $= \frac{2{,}510}{909} = 2.76$, say 3.

If the dynamo is then found to over-compound a little too much, some of the current can be diverted from the series winding by means of a resistance connected in parallel.

(*To be continued.*)

Abridged List No. 3,272 of Electric Light and Power Accessories has just been issued by the electrical department of **Baxendale and Co., Ltd.**, Miller Street, Manchester. The 32 pp. contain details and prices of most standard lines required by electrical engineers and contractors in the ordinary course of business.

We have received from **Ozonair, Ltd.**, of 96, Victoria Street, London, S.W.1, a copy of a pamphlet describing the system of pure air ventilation installed on the Central London Railway, which has now been in continuous service for twelve years with eminently satisfactory results. The pamphlet is worth careful perusal by all who are interested in the efficient and healthy ventilation of tunnels, factories, railway stations, etc., and, in fact, of all large buildings.

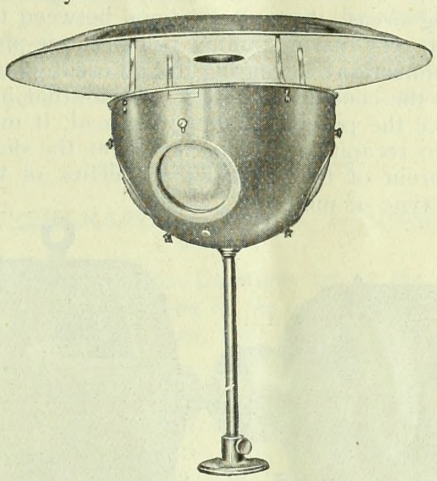
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A NEW WAY OF LIGHTING WORK BENCHES.

The satisfactory and economical lighting of work benches has always been a problem. That operatives in the winter often lose a great deal of time every day through inefficient lighting is only too true. To be completely effective as a substitute for good daylight, the artificial illumination must be of high intensity, but it must also be glareless and properly directed, and it is not always easy to combine these three characteristics.

With these main objects in view, the British Thomson-Houston Co., Ltd., have introduced a standard called the "Universal Bench Light," which is, it is claimed, a vast improvement on anything of its kind now in use, and is especally suitable for the illumination of machines that are employed in groups on benches, as in boot and clothing factories, where the eyes of the machinists are of necessity fixed on one spot, and where the closeness of the work requires powerful but glareless illumination. The following is a brief description thereof:—

The B.T.-H. Universal Bench Light (type 616/A) performs practically a triple function—firstly, the illumination of the working points at high intensity; secondly, the illumination of the bench at medium intensity; thirdly, the general illumination of the room at low intensity.



GENERAL VIEW OF B.T.-H. UNIVERSAL BENCH LIGHT.

The fitting consists of two essential portions, namely:—

(*a*) The body, containing lampholder and furnished with four condensing lenses spaced radially round the lamp, this body being mounted on an adjustable support or stem intended for attachment to the top of the bench.

(*b*) An over-reflector, fixed on the top and slightly above the body, diffusing the upward light over the bench and having a central opening fitted with diffusing glass for the general illumination of the apartment.

The body consists of an aluminium spinning with an all-porcelain lampholder mounted on a central tube (an extension of the stem) and having four openings placed in pairs diametrically opposite one another. Each of these openings is provided with an adjustable housing carrying condensing lens and diffusing glass at such a distance from the lamp that the lamp filament (occuping a central position) is focussed by the lens and a powerful beam of light consequently projected therefrom. Universal adjustment (to a limited degree) permits of the direction of the beam being altered to some extent. The stem, which is rigidly attached to this body, passes through a base-plate (for attachment to the bench), and is capable of vertical and rotary adjustment therein.

Four stalks attached to the body support the over-reflector so that it is carried in such a position that the upward light from the lamp can pass up, and is then reflected down by the reflector without the lamp itself being visible from normal positions. As already mentioned, a diffusing glass is fixed in an opening in the centre of this reflector, which permits a small amount of the light from the lamp to pass directly upwards to illuminate the ceiling or roof of the room.

When the fitting is fixed in its correct position, four concentrated beams of light are obtained, one of which may be directed to the working point of each of four machines. By this means a high intensity of light (in the neighbourhood of 60-foot candles) is projected on the working points of four machines, while at the same time the bench is generally illuminated all from a single lamp.

This device is at present made in one size only, suitable for 100-watt Mazda projector type lamp. The standard finish is grey enamel, with the reflecting parts white and the small parts nickel-plated. Further particulars of the Universal Bench Light will be gladly supplied to all interested on application to the B.T.-H. Co., Ltd., Mazda House, 77, Upper Thames Street, London, E.C.4.

Questions and Answers by Practical Men.

RULES.

QUESTIONS: *We invite our readers to send us questions, preferably on technical problems that have arisen in actual practice. Questions which we consider of sufficient interest to our readers will either be replied to under "Answers to Correspondents" or replies will be invited from our readers. One shilling will be paid for the question which we select for competitive replies in this column.*

ANSWERS: *A fee of 10s. will be paid for the answer which we consider shows the greatest merit, and 5s. for the one we select as second best. In judging the replies, importance will be attached to clearness and conciseness, as well as accuracy. The Editor reserves the right to make no award, or to accept only one reply, if, in his opinion, the answers received do not possess sufficient merit. Competitors desiring the return of their manuscripts, if unaccepted, should enclose stamped addressed envelope.*

Write on one side of the paper only, and if diagrams are sent, draw them on a separate sheet of paper attached to the manuscript. Competitors may adopt a "nom de plume," but, both in the case of questions and answers, the competitor's real name and address must be sent with the manuscript as a guarantee of good faith. No correspondence will be entered into with regard to successful replies. The Editor's decision is final.

Commencing with Question No. 101, a Diploma of Merit will be awarded to the six competitors who win the first or second prize the most times during the next twelve months.

The words "Questions and Answers" or "Q" and "A" should be placed at the top left-hand corner of all letters intended for this column.

QUESTION NO. 165.

I hear that in America they have an instrument known as a foot-candle meter. What is this for, and how does it work?—"WIREMAN."

QUESTION NO. 166.

Can any reader give me details of a good electrical fire alarm system? I wish to instal it in a small workshop where the temperature is always varying owing to the intermittent use of a muffle furnace.—"TURNER."

(*Replies to Questions Nos. 165 and 166 must be received not later than August 25, 1923.*)

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SINGLE-PHASE COMMUTATOR MOTORS.

Their Progress and Reasons Why They Demand the Attention of Power Engineers.*

(*Continued from page* 377.)

Some further details with regard to this type of motor are to be found in the *Journal* of the I.E.E., vol. 60, page 314. In Fig. 1 is shown a diagram giving relative weights, efficiencies and of single-phase and direct current motors of the same horse-power and speed. The weights of the single-phase motor are little more than two-thirds of the corresponding direct current motor, and efficiencies are only very slightly lower.

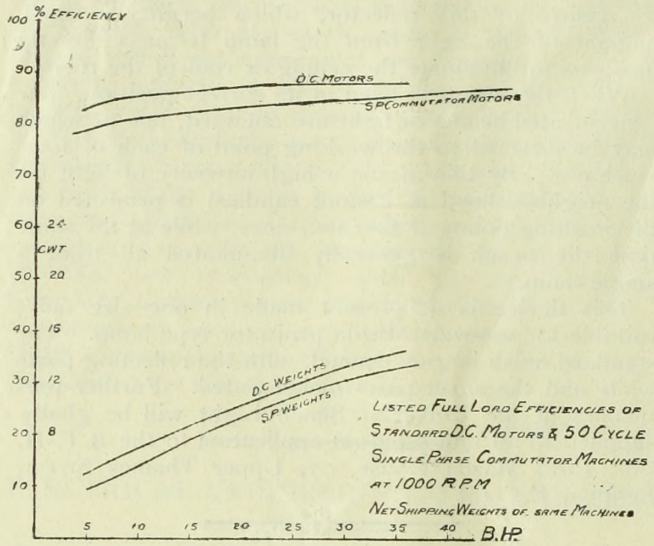


Fig. 1.

While discussing the subject of distribution, it may be as well to say a few words about an old fallacy, viz., that some polyphase systems, for instance the three-phase system, are more economical of copper than others. Although exploded many times, one occasionally comes across it still. It depends on a rather subtle point whereby a polyphase system of a given voltage is compared with a single-phase system of a lower voltage, to the disadvantage of the latter. For instance, consider a 400 volts three-phase system, arranged with 230 volts to neutral, for lighting. If this transmits 100 k.v.a., it will carry a current of 144 amps. per phase, and, allowing 1,000 amps. to the square inch, will require a total cross section of .432 in.

Compare this system with a single-phase system of the same voltage to neutral, viz., 230 volts, thus giving 460 volts across the outers, we find that to carry 100 k.v.a. we should have 216 amps. in each line requiring, again at 1,000 amps. per square inch, .432 square inches of copper.

The fact is that for a given voltage to earth, regarded as being at the same potential as the neutral point, all systems require the same amount of copper.

For given volts between lines, however, the volts to earth are higher on the three-phase than on the single-phase system, and still higher on the two-phase four-wire system. The more wires we have the greater is the voltage to earth for a given voltage between lines, and hence the less copper does the system require.

Clearly by having a sufficient number of lines we can get any voltage to earth we wish, but, were this argument sound, we should find the two-phase four-wire system, or systems having even more wires, in universal use to the exclusion both of three-phase and single phase systems. Competent distribution engineers, however, find that there is no real economy to be found on these lines.

Finally, it may be of interest to explain just how the single-phase system may be arranged as a feeder to the large polyphase system, enabling it to deal with lightly loaded areas without excessive cost.

The polyphase system of distribution is arranged with a number of concentric systems of ring mains. Outside the outermost set of ring mains will be a number of small towns or self-contained districts, whose consumption is carried in more or less radial direction, one district being fed from one pair of phases and the next along the ring mains being fed from another pair of phases. As the density of the load in these isolated districts grows, it may be desirable to introduce polyphase currents or to lay another system of ring mains. This can be readily brought about by connecting areas, these connections between the inner and outer sets of ring mains being single-phase, adjacent connections belonging to different phases.

Due to the considerable lapse of time that has taken place since the previous paper was read, it may be of interest to recapitulate to some extent the description given therein of the principal properties of the compensated type of motor.

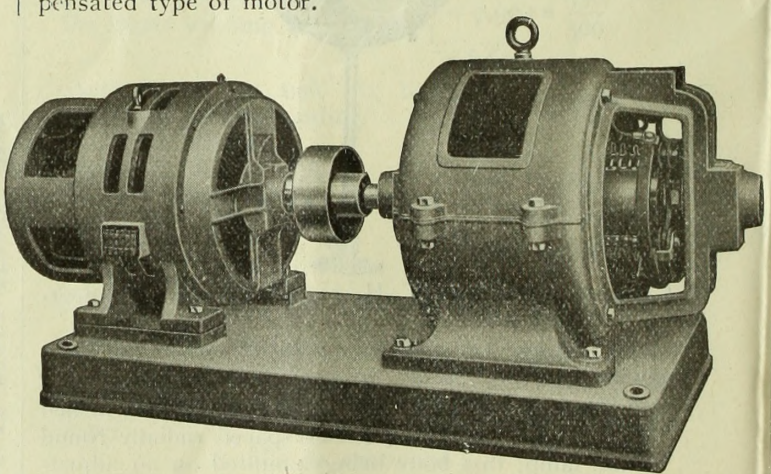


Fig. 2.

In order to grasp the characteristics of this type of machine most fully, it may be useful to compare it with a direct current machine of similar rating, such as, for instance, would be coupled to it to form a single-phase direct-current motor generating set. The single-phase machine will be considerably smaller in outside diameter, as evidenced by the curve of weights (Fig. 1) and illustration (Fig. 2) than the direct current, and lighter in weight. It was proved some years ago that the single-phase railway motors designed by the Oerlikon Co. for the Swiss Federal Railways (Lotsch-

* A Lecture delivered before the N.A.S.E., by F. Creedy, Esq., A.M.I.E.E., A.C.G.I.

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berg Tunnel) were lighter than the corresponding direct current machines, and it is also true for constant speed continuous rated motors, the single-phase motor being intermediate in weight, behind the polyphase and D.C. motors. On the other hand, the rotor commutator diameter and commutator length will be much greater than the direct current, the characteristic feature of the single-phase machine being its larger commutator and more numerous brushes.

In fact, the reduction in size and weight of the single-phase, as compared with the D.C. machine, is due to the substitution of the light laminated core and cast-iron housing for the heavy yoke, poles and shunt coils of the direct current machine. Continuing the comparison with the direct current machine, we find, on examining the brush gear, that it is divided into two sets, one completely short-circuited in most types of motor, the other brought out to a pair of terminals. The latter set contains only about half the contact surface of the former set, and is spaced half a pole pitch away from it on the commutator surface. Without for the moment describing the connections of the starting gear in detail, it will be noted that, at starting, the rotor terminals are completely open-circuited, or else closed through a choking coil, while, as the machine speeds up, the rotor circuit is closed through an auxiliary stator winding in the case of a self-compensating machine or the secondary of a transformer. In some special instances, the starting reactance is merely cut out, or by means of special design it is possible for the motor to operate from starting to full speed without change of connections.

(To be continued.)

TELEGRAPHY.—GRADE I. (1923).*

Being Solutions to the Questions set by the City and Guilds of London Institute in the Grade I. Examination in Telegraphy held in May, 1923.

(*Continued from page* 398.)

Q. 8.—Describe a method of treating wooden telegraph poles to prevent their rapid decay. About how long do such poles last in actual practice, and how long do untreated poles last?

A. 8.—The timber used for telegraph poles is generally Scandinavian red fir, which is felled during the period between November 1 and the last day of the following February, when the trunks of the trees are free from sap. After being stripped of their bark and smoothed down, the poles are thoroughly dried and seasoned by stacking them in such a manner as to allow a free circulation of air. When seasoning is completed the poles are subjected to a preservative process in order to prevent decay caused by wet rot, and thus prolong their lives. In the most recent method of treating timber, known as the Ruping process, the poles, after being well seasoned, are placed in an airtight cylinder and subjected to an air pressure of 75 lb. per sq. in. Creosote, a strong antiseptic, is then admitted and forced by an air pressure of about 225 lb. per sq. in. well into the timber. When impregnation is judged to be complete, the pressure is reduced, with the result that the compressed air in the interior of the wood expands and drives out some of the creosote. The quantity of creosote injected on an average is about 6 lb. to the cubic foot, the poles assuming a dark brown colour.

Such a method preserves the poles from rot, the seasoning and antiseptic processes neutralising the fermentative properties of the sap. Timber when treated in this manner is less affected by air, moisture and changes of temperature. The Ruping process has the advantage that, when the poles are quite dry and free from exudations of creosote, they can be satisfactorily painted, which was not the case with some of the older methods of treatment. The method renders the poles waterproof, and therefore impervious to moisture.

The life of creosoted poles exceeds thirty years, but untreated poles do not, as a rule, last more than five or six years.

(To be continued.)

* *The standard text books for this Grade are: "The Telegraphists' Guide," by Bell & Wilson (20th thousand, 3s. 6d. net), and "Questions and Solutions in Telegraphy and Telephony, Grade I." by Few (5th edition, revised, 5s. 6d. net).*

Various Items.

Dividends.—Interim dividends at the rate of 6 per cent. per annum to June 30 last will be paid by the Yorkshire E.P. Co., Ltd., and 7 per cent. per annum by the Electrical Distribution of Yorkshire, Ltd.

Electrical Materials Wanted.—By the Argentine State Railways for the year 1924, including telephone and telegraph material. Details from D.O.T., 35, Old Queen Street, S.W.1. Mention reference 8495/F.L./G.P.

Dividend.—The directors of the Charing Cross, West End and City El. S. Co., Ltd., have declared an interim dividend of 5s. per share on the ordinary shares of the West End undertakings for the half-year ended June 30, 1923.

Annual Meetings.—The directors of the Marconi Wireless Telephone Co., Ltd., have decided to defer the date of the annual meeting until they are in a position to give detailed information in regard to the agreement now under negotiation with the Government. Meantime, they state that the profit to be divided will not be less than that of the previous year.

Motor Ships Replacing Steamers.—According to the current issue of *The Motor Ship*, it would appear that motor ships are now almost equally as popular with owners as steamers, for during the period from March 31 to June 30 the tonnage of new vessels for which orders were placed was in the proportion of 43 per cent. oil-engined vessels and 57 per cent. steamers.

South Africa.—The Electricity Supply Commission, which has been formed under the Union of South Africa Electricity Act, 1922, was appointed by the Union Government on March 1, 1923. It consists of a chairman (a full-time member, Dr. H. J. van der Bijl), with two part-time members (Messrs. R. J. Niven and R. J. Fulton). The headquarters are in Johannesburg, where it opened its offices on May 1 last. Several electrical schemes are already engaging the Commission's consideration, including the electrical power requirements of the Witbank area in the centre of the Transvaal Gold Fields, and a new municipal power station at Durban. The Commission has very wide powers, and much is expected from it in the direction of fostering industry, development, railway electrification, and the establishment of by-product industries.

BOOKS *Write to* **S. RENTELL & Co., Ltd.** **And ask for Catalogue No. 10.**

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Reviews of Books, &c.

[*Books noticed in this column will be sent from* ELECTRICITY *Office to any part of the world, for the published price, plus ten per cent. for postage (minimum 2d.), and orders will be appreciated.*]

HOW TO MAKE A VALVE RECEIVING SET. By A. V. Ballhatchet, M.Inst.J.E. (Percival Marshall, 6d. net.)—To all persons interested in matters wireless, and particularly to those possessing a workshop or the average amateur mechanic's toolbox, this little book will provide the necessary information to enable them to make up a two-valve receiving set comprising high-frequency valve and detector valve. Details for a low-frequency amplifier unit are also given.

To assist those who do not feel capable of making the components, the set is so designed that purchased components may be used, as an alternative to making them. The lay-out is practical, both from the points of view of design and operation. We particularly like the use of the variable grid leak, and suggest to our readers that, should they purchase the book and make the set up, that some kind of variable grid leak such as described should be used.

The author suggests two methods of increasing the signal strength. One is by adding an additional high-frequency amplifying valve before the first in the set, but for the average amateur we should not advise this, but rather his second suggestion should be adopted, namely, the addition of a low-frequency amplifying valve after the detector valve. The latter does not complicate the tuning, and does provide very much louder signals.

The book, in common with others from the same source, is very good value for the information it contains.

CLOCK REPAIRING AND ADJUSTING. By W. L. Randell. (Percival Marshall, 9d. net.)—This little book is a welcome addition to the "Model Engineer" series, which series must have a world-wide reputation. There can be very few persons, indeed, to-day interested in any engineering matters that have not benefited at some time or other by reading books in this series, which contain simple and practical information. No. 50, "Clock Repairing and Adjusting," more than attains the standard of its predecessors.

The subject is dealt with fully from tools to cuckoo clocks, and is so clearly written that, after reading the book through, one feels almost ready to undertake the repair of the first clock that can be found. Time-keeping and striking mechanisms are described, together with various types of escapements, and clocks are dealt with generally.

The book closes with, perhaps, one of the most important chapters, and that is setting a clock in beat.

Clock-making is a hobby to be recommended to all who possess a small workshop. The various tips and gadgets of clockmakers are particularly worth learning. They can be applied with much success in general instrument making work. Indeed, Mr. Randell's book is one that can be read even by qualified instrument makers.

To amateur engineers, whose hobby is electric clocks, the book should be of use, as it describes mechanisms not dealt with in the ordinary way by books on their special subject.

There is one thing Mr. Randell does not describe to us, and that is, the watchmaker's method of holding the eyeglass. He, perhaps, considers this a matter of muscle and not mechanics.

Trade Notes.

In their new leaflet No. F.3069, the **Gen. Elec. Co., Ltd.**, of Magnet House, Kingsway, announce that considerable reductions have been made in the prices of their "Equiluxo" glassware, and a very favourable opportunity is thus presented for traders to renew their stocks in readiness for the autumn lighting season. They have also issued a special list of "Doriclite" semi-indirect all-glass pendants which make semi-indirect lighting possible in lofty premises or where a white ceiling is not available.

Messrs. James McMillan and Co., of Clun House, Surrey Street, London, W.C.2, have just issued circulars dealing respectively with the "Telur" Recorder for timing telephone messages, and the "Glo" Electric Soldering Iron, both of which are likely to interest readers of this paper.

A splendid catalogue of Holophane glassware and fittings has been issued by the **Siemens and English Electric Lamp Co., Ltd.**, of 38-39, Upper Thames Street, London, E.C.4. It contains a large amount of comprehensive data on the subject of scientific illumination, together with diagrams showing how to obtain the best effect in any particular situation, and it will therefore prove of direct interest to every consultant and contractor who wishes to give a client the best and healthiest lighting value at a moderate price consistent with quality and efficiency. The list (No. 64) will be sent willingly on proper trade application.

The **Whitecross Co., Ltd.**, Warrington, have just issued a catalogue giving illustrations and details of their "Armco" electrodes for arc welding. These are made from a special quality of ingot iron which the company claim to be eminently suitable for electric welding work, and they should therefore appeal to the ever-growing circle of welding engineers. The list will be sent on application, and is worthy of careful perusal.

An excellently printed and illustrated series of catalogues has come to hand from **Messrs. Smart and Brown**, of Erith, who are specialists in small generating sets from 2 to 45 b.h.p. The list should appeal to every electrical contractor who has to submit estimates for private lighting plants for country mansions, factories, etc.

Siemens and English Electric Lamp Co., Ltd. (38-9, Upper Thames Street, E.C.4), have issued a monthly trade price list for August in the form of a large folding sheet. The sections are conveniently arranged, with illustrations, and all items in general use by the electrical contractor are listed. In addition, particulars are included of some special offers now being made by the company. All electrical contractors should see that they get a copy.



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A POPULAR SCIENTIFIC WEEKLY JOURNAL
ELECTRICITY
A PRACTICAL TRADE JOURNAL

AUGUST 17, 1923.

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"FACTORY LIGHTING DESIGNS."

The Lighting Service Department of the British Thomson-Houston Company, Ltd., have just published their first handbook, "Factory Lighting Designs."

It deals, as its name implies, with the design of electric light installations in factories and workshops in a practical manner which eliminates the necessity of calculations.

Well-illuminated factories and workshops in this country are very few, and this is due to the fact that, up to the present time, rule-of-thumb methods have been adopted when planning an installation. That such methods do not produce the best results has been realised by engineers for some time, and this, in the face of the general demand for more light and better light, has necessitated a considerable amount of spade work to uproot old-fashioned ideas.

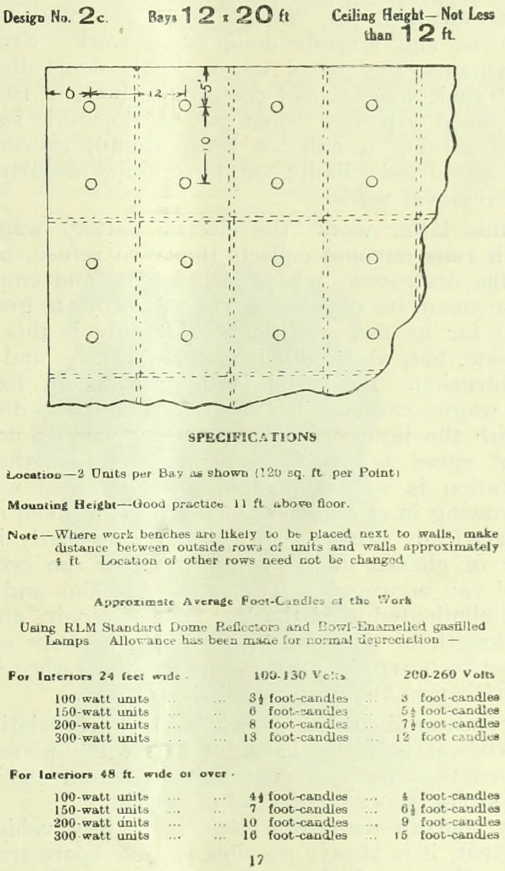
There are several important factors which are essential features of the successful lighting system, and which require very careful consideration, such as the correct design and spacing of the lighting units, sufficient intensity, and absence of glare and harsh shadows. All these points have been taken into consideration in the planning of the handbook, the practical data given being based on a sound engineering and technical foundation.

The consideration of the factors to produce the best results has hitherto necessitated tedious calculations, and it is realised that there are very few who have sufficient time at their disposal to devote to calculations. "Factory Lighting Designs" solves this difficulty because no calculation whatever is necessary. With the aid of this handbook the technicalities of illumination are reduced to mere diagrams and tables, and the correct lighting equipment for any industrial interior can be found at a glance.

The illustration is one page from "Factory Lighting Designs"; it shows the planning of a design for a factory where the bays are 12 by 20 ft., with a ceiling height of not less than 12 ft. It will be noticed that the intensity of illumination at the work depends upon the size of the lamp used in the unit. The amount of illumination necessary for almost any industrial operation can be obtained from a table at the end of the handbook.

The booklet not only gives details of designs, but also clearly explains various lighting fundamentals. It discusses why the lighting units are located according to bays. It also explains in a concise manner mounting heights, with relative ceiling heights, and the effect of using fewer units than those prescribed in the designs. It also deals with work-bench auxiliary lighting, local lighting, and in a chart comparison of good and bad lighting one can readily judge the advantages of the former and the disadvantages of the latter.

One of the interesting features of "Factory Lighting Designs" is the section dealing with the foot-candle meter. This is an instrument which enables illumination, in terms of foot-candles, to be read direct from a scale in much the same manner as one reads temperature degrees with a thermometer. For this reason the instrument is valuable, since it strips light measurement of all its technicalities and it entirely eliminates guesswork. By its means the engineer can himself make sure that an operator is obtaining sufficient illumination for the work in hand.



The architect, engineer and contractor who are responsible for the installation and maintenance of electric lighting installations have a valuable assistant in "Factory Lighting Designs." It is an acquisition to any bookshelf, and, if kept at hand, it will do your thinking for you. It is not for sale, but will be sent to those who believe that "better lighting means better work." It can be obtained from the Lighting Service Department of the British Thomson-Houston Co., Ltd., 15, Savoy Street, Strand, London, W.C.2.

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THE PROGRESS OF THE ELECTRIC VAN AND WAGON.

By JAMES TYLER.

The electrical van or wagon makes no noise whilst doing its work; from the publicity point of view this is excellent—as a selling point—on the other hand, some members of the public, including the friends of the petrol vehicle, seem to imagine that because there is no noise and rattle, no noxious fumes and streaks of oil, or similar evidence with electric wagons, that therefore they do not exist.

The facts are exactly the reverse. The electric wagon is being ordered in greater numbers each month, and a very large number of these are repeat orders. True, there will be cases in which the electric has been taken off its work and made to give way to a petrol wagon; but these instances are not only few, but are instances in which an electric battery wagon should not have been chosen.

The electrical vehicle is essentially a runabout, and short, choppy journey vehicle; which the petrol wagon is quite unsuited for, though there are thousands of such vans and wagons doing such work. Still, the fact remains, the petrol wagon is the long distance, rapid transit vehicle, and costs more both in running and upkeep expenses when put to do work such as that of serving a milk or bread round, grocery delivery within town limits, or the sanitary department's refuse removal work.

In this latter work the electric battery wagon is ideal, it runs out and collects the town refuse, brings it to the destructor, where it is burnt and employed to raise steam for dynamo driving, in order to generate current for its own working. Not only is this work well done, but, above all, it is done silently and without obtrusion. Its speed is quite sufficient for any heavy wagon carrying heavy goods about the district; and with the lighter type of delivery van its day-in-day-out speed is good, owing to the fact that its acceleration is so easy, rapid, and obtained without the throwing in of clutches. This point in itself makes any electrically driven vehicle much less costly in the matter of chassis or body upkeep than the ordinary type of van or wagon. The racking strains and jerks are all eliminated, and the low cost of repair, and the great length of time the wagons can be kept on the road between repairs, makes up for the rather heavy depreciation on the batteries themselves.

The feature about this point, battery depreciation, is that renewal is fairly easy, and that the plates are improved year by year, not only in actual efficiency, but in strength per one pound of weight.

In a concern using the electric battery vehicle to any extent, it is always possible to have spare trays of cells, so that a vehicle coming in from one day's run of, say, 50 completed miles can have the exhausted set taken out and another set fully charged run in, and be off again for further work.

The correct use of such vehicles is shown by certain traction undertakings using both the electrical and petrol vehicles for their overhead department's inspection and repair work.

The emergency on the road, for which a sudden call comes in, and which requires as prompt a dash as the fire engine, is met by the petrol wagon; and in the present state of the battery vehicle development it would be folly to attempt to make the electrical wagon do such work.

The careful inspection of the overhead line, however, which goes on day by day, week in and week out, is quite another matter.

In this work, each portion of the overhead line is examined with minute care from the overhead wagon platform; the easy, smooth drive of the electrical vehicle is beyond question, and a great contrast to the jerky and fuel-wasting drive of the rival method.

Whilst the battery is the chief problem, the life being at present from two to three years, yet improvement can be made in other directions which will assist the battery by reducing the weight to be hauled about.

Every battery vehicle should be submitted to the keenest possible inspection from a *mechanical* point of view; every point where better and more scientific design, or the use of better, if rather more expensive, material can be used to reduce weight, should be taken advantage of. The motors themselves will pay for the highest possible efficiency being maintained, as this again will reduce weight. That is, it will pay to spend 10 per cent. above the cost of an ordinary industrial type motor if the weight can be reduced by 10 per cent. and the efficiency carried up 2 per cent.

In the matter of charging, it must be said that Borough Electrical Engineers are not doing all they might to provide charging stations; this can be made a most attractive all-night load.

In one town the tramway authority are considering the lay-out of a charging garage, owing to the business not being catered for by the supply department. In such cases where the town supply is direct current it will be a fairly easy matter to arrange charging machines as balancers across the system; on A.C. systems it will pay best to take the charging current from the A.C. side, through a special motor converting set. In neither case should the supply be taken from the tramway overhead, as this is perhaps more likely to be interrupted by the necessary opening of circuit breakers, due to faults, temp. shorts, etc. A tramway authority, with a staff engaged repairing and car washing during the night, could quite easily find room and time to run an overnight charging garage, and it would pay handsomely.

The refuse destructor is, of course, in another category altogether; it can lay its plant out to suit its charging needs first, and its lighting and power circuits as a secondary matter.

The electric battery vehicle industry offers a good field to the promising practical youth, well armed with technical data relating to both mechanical and electrical sides.

He may specialise on vehicle bodies, specially light reduction gears of high efficiency and great strength, problems of road adhesion, and weight distributed on each axle; or he may prefer to specialise as a battery expert, in which case he must be more than a chemist, and more than an engineer. He must understand the chemical side thoroughly, and also should make a special study of the material from which accumulator plates are made, and the methods of gaining greatest active surface, highest possible strength, and lowest possible weight, combined with greatest electrical output. In fact, he must work to develop a cell which will give a good output, charge rapidly, stand knocking about, and have a five years' life.

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In this direction alone a by no means unattractive career could be made.

As mentioned earlier, the motors, their controls, and wiring can find plenty of scope for ingenuity. One thing is quite certain, namely, that the electrical battery vehicle has come to stay, and is going to be in the immediate future a quite considerable industry.

THE NEW POWER STATION AT PRESTON.

The new Ribble Power Station, at Preston, is intended for an electrical installation to develop 25,000 kw., with two turbo-generators, each of 12,500 kw., equivalent to 15,000 h.p. each. The area of ground covered by the various buildings is 3,700 square yards, and there is land on all sides for extensions.

Over 1,100 tons of steel have been required for the framework, and only 10 tons of girders now require to be placed in position. The beds of the boilers have been completed, and the boilers, five in number, will be installed shortly. A 60-ton steam crane has been required for haulage purposes. All the flooring and walls are fireproof. Concrete plays an important part in the construction work, and over 273 bags of cement have been used in one average day's work. Special culverts will take the place of condensing towers, to the summit of which water used for condensing purposes would have had to be pumped. The close proximity of the Ribble is one of the advantages this station will possess, which is not enjoyed by any other in the county. At present sufficient water flows down the river to keep the whole of the initial installation cool without any weir. When it becomes necessary to extend, a weir will be built. It is anticipated the power station will attract important industries, and that large mills and works will be erected on the land which is available. There is no reason to doubt that the contract time of 42 weeks will be observed in finishing the scheme. That means somewhere about next April or May generators will be working. The scheme of distribution includes the establishment of two sub-stations on the Preston side of the river. By an arrangement with the English Electric Co. (contractors for the station and plant) the main sub-station will be on the Dick, Kerr works of the company in Strand Road. It will be a joint station for the high pressure supply required on the works, and also for the low pressure supply required in their workshops, and in other works and mills in the district, as well as for the domestic lighting and heating load. This arrangement has obviated the necessity of the Corporation building a separate sub-station in Marsh Lane (at an estimated cost of £5,500) as well as the cost of maintaining a separate staff. The second sub-station will be erected at Ribbleton.

The scheme provides for double transmission cables between the new station and Blackburn Power Station, which will couple up both installations, thus permitting interchanges of power in emergencies, and will provide available current for towns and works near the line of route. The cost of the connecting cables will be shared equitably by the two Corporations, who will also share the advantage of doing away with the necessity of providing a separate emergency set of generators at each of the stations.

The total cost of the scheme, for which Mr. J. A. Robertson, of Manchester, is responsible, is within half a million, the estimated cost of the erection and equipment of Ribble Station being £409,150, and of the transmission cables between Preston and Blackburn, the two sub-stations and their equipment, mains and services, meters, etc., about £74,826.

CRYPTO PATENT RECTIFIER.

A Highly Successful Method of Charging Accumulators from A.C. Supply Mains.

To those who are interested in accumulator charging, and especially to those who have faced the problem of doing this from the A.C. supply mains, the following article should be of great help. During the last few months it has become increasingly evident that a cheaper method of charging accumulators would have to be evolved in order to meet the popular demands of wireless broadcasting, and, quite apart from cost, users of accumulators are severely handicapped if they are unable to utilise the A.C. town supply.

Those who are acquainted with chemical, thermionic and vibrator rectifiers do not need reminding that each of these types have certain inherent disadvantages.

It is sufficient to say that, owing to their messiness, cost of renewals or low frequency, the foregoing methods are far from satisfactory.

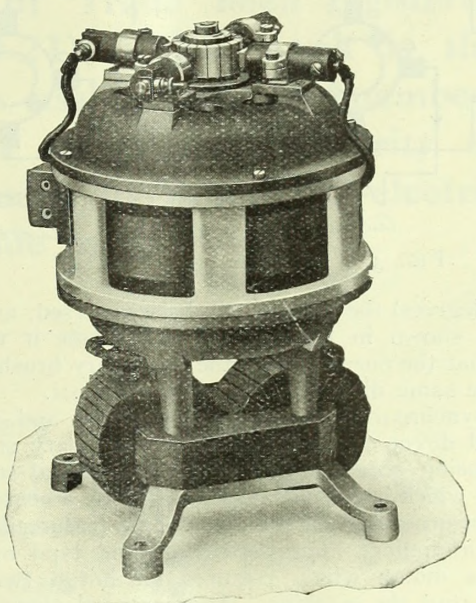


Fig. 1.—Crypto Commutating Rectifier, Size CB.

The Crypto patent rectifier, as shown in Fig. 1, however, claims to be free from these objectionable characteristics. It consists essentially of a synchronous motor running off the A.C. supply, which also feeds the primary winding of a suitably wound static transformer. The alternating current from the low-tension secondary of the transformer is then converted into a unidirectional current by means of a special com-

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mutator mounted on the shaft of the synchronous motor. The action of rectification can best be described with the aid of a sketch.

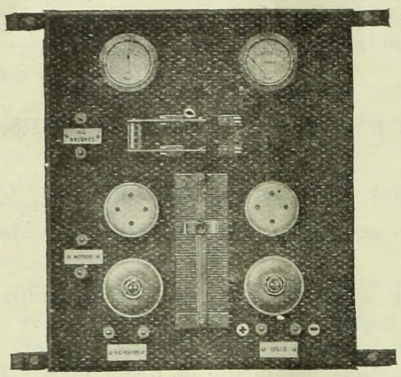


FIG. 2.—BATTERY CHARGING SWITCHBOARD FOR CRYPTO RECTIFIER.

The commutator consists of two copper parts separated by two insulated sectors as shown in Fig. 1. Four brushes are made to press on the commutator, and the A.C. supply is led to two opposite brushes. It is, therefore, evident that if the commutator is revolving at synchronous speed governed by the frequency of supply, the current at one instant will flow as indicated in Fig. 3. When the commutator has moved through 180 electrical degrees (in this case 90

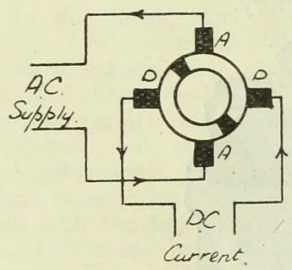


FIG. 3.

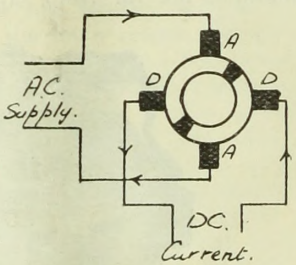


FIG. 4.

actual degrees) the current will have reversed, and will flow as shown in Fig. 4. In both cases it will be noted that the current from the secondary brushes (D) is in the same direction, i.e., unidirectional.

The synchronous motor is self-starting, and can be switched direct on to the line, the necessary starting torque being obtained by means of a special starting winding which is cut out automatically by a centrifugal switch incorporated on the rotor. This feature is novel and is a distinct improvement on the type of synchronous motor which requires an initial twist by hand to start the machine. Another particular feature is the fact that there is no electrical connection of any sort between the high-tension A.C. supply and the cell terminals—that is to say, the set is not auto-connected. This makes it impossible for a shock to be obtained from the main A.C. supply.

In order to make the apparatus as complete and compact as possible, the motor is made with a vertical spindle, and the bottom end plate of the machine is provided with legs with sufficient clearance to mount the static transformer. This makes a complete unit very easy to handle. As an indispensable accessory, a switchboard is supplied, as shown in Fig. 2, which reduces the method of working to an absolute minimum. All that is necessary to do is to connect the machine, switchboard and cells, as shown in the accompanying diagram. The machine is then started up by closing the motor switch. The charging current can be varied in two ways. Generally speaking, all the necessary regulation can be obtained by means of the series regulator provided on the switchboard. If, for any reason, a still greater reduction is required, or a smaller number of cells are being charged, it is possible to reduce the voltage by utilising an additional tapping provided on the low-tension side of the static transformer.

This machine is made in several sizes, the smallest giving an output of 15 volts 5 amps. The next size gives an output of 15 volts 10 amps, whilst still larger machines can be manufactured to give up to 60 volts 70 amps, being chiefly used for cinema arc lighting.

From the point of view of cost, either initial or running, this machine shows itself highly efficient. The smallest machine, size CB, giving 15 volts 5 amps, runs for five hours, with a consumption of approximately 1 unit. This shows the cost per hour at about ½d., taking current at 2½d. per unit.

Questions and Answers by Practical Men.

RULES.

QUESTIONS: *We invite our readers to send us questions, preferably on technical problems that have arisen in actual practice. Questions which we consider of sufficient interest to our readers will either be replied to under "Answers to Correspondents" or replies will be invited from our readers. One shilling will be paid for the question which we select for competitive replies in this column.*

ANSWERS: *A fee of 10s. will be paid for the answer which we consider shows the greatest merit, and 5s. for the one we select as second best. In judging the replies, importance will be attached to clearness and conciseness, as well as accuracy. The Editor reserves the right to make no award, or to accept only one reply, if, in his opinion, the answers received do not possess sufficient merit. Competitors desiring the return of their manuscripts, if unaccepted, should enclose stamped addressed envelope.*

Write on one side of the paper only, and if diagrams are sent, draw them on a separate sheet of paper attached to the manuscript. Competitors may adopt a "nom de plume," but, both in the case of questions and answers, the competitor's real name and address must be sent with the manuscript as a guarantee of good faith. No correspondence will be entered into with regard to successful replies. The Editor's decision is final.

Commencing with Question No. 101, a Diploma of Merit will be awarded to the six competitors who win the first or second prize the most times during the next twelve months.

The words "Questions and Answers" or "Q" and "A" should be placed at the top left-hand corner of all letters intended for this column.

QUESTION NO. 165.

I hear that in America they have an instrument known as a foot-candle meter. What is this for, and how does it work?—"WIREMAN."

QUESTION NO. 166.

Can any reader give me details of a good electrical fire alarm system? I wish to instal it in a small workshop where the temperature is always varying owing to the intermittent use of a muffle furnace.—"TURNER."

(*Replies to Questions Nos. 165 and 166 must be received not later than August 25, 1923.*)

Electric Postal Meter.—An electrically driven postage meter that will seal and stamp an envelope, marking the requisite postage all in one operation, has been approved by the Postmaster-General in Ottawa. Several of the new meters are already in operation in Ottawa and Toronto, and with their general use it is expected that a large saving will be effected in the manufacture and despatching of postage stamps. Each machine is furnished with a permit number, and is under direct control of the P.O. Dept.

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THE Cable Makers' Association call the attention of manufacturers, sellers and buyers of electric cables to the fact that the letters

C.M.A.

have by Permission of the Board of Trade been registered as a trade mark (Nos. 422219-20-21). This mark is the property of the Association and is usable only by members of the Cable Makers' Association under the authority of the Association. The use of such mark by others on electric cables is an infringement of this trade mark.

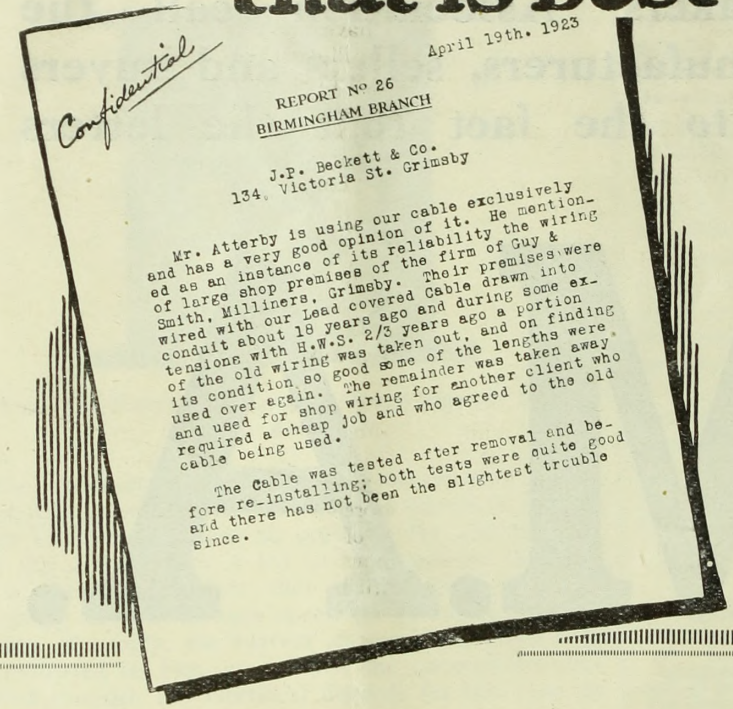
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W. T. Henley's Telegraph Works Co., Ltd.
The India-Rubber, Gutta-Percha & Telegraph Works Co., Ltd.
Johnson & Phillips, Ltd.
Liverpool Electric Cable Co., Ltd.
The London Electric Wire Co. and Smiths, Ltd.
Siemens Brothers & Co., Ltd.
St. Helens Cable & Rubber Co., Ltd.
Union Cable Co., Ltd.
Western Electric Co., Ltd.

Advertisement of the Cable Makers' Association, Sardinia House, Sardinia Street, London, W.C.2.

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A Confidential Report that is best made public-



Confidential

April 19th. 1923

REPORT No 26
BIRMINGHAM BRANCH

J.P. Beckett & Co.
134, Victoria St. Grimsby

Mr. Atterby is using our cable exclusively and has a very good opinion of it. He mentioned as an instance of its reliability the wiring of large shop premises of the firm of Guy & Smith, Milliners, Grimsby. Their premises were wired with our Lead covered Cable drawn into conduit about 18 years ago and during some extensions with H.W.S. 2/3 years ago a portion of the old wiring was taken out, and on finding its condition so good some of the lengths were used over again. The remainder was taken away and used for shop wiring for another client who required a cheap job and who agreed to the old cable being used.

The Cable was tested after removal and before re-installing; both tests were quite good and there has not been the slightest trouble since.

Another Henley Cable that is working overtime

HENLEY

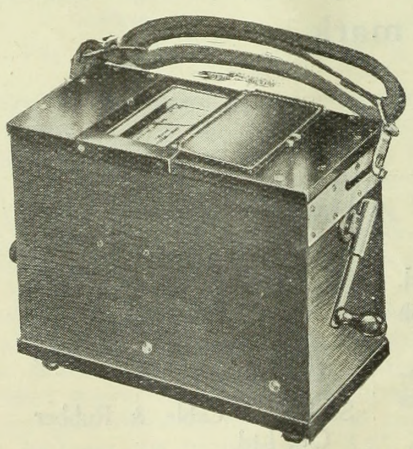
CABLES & WIRES

W. T. HENLEY'S TELEGRAPH WORKS Co., Ltd.,
B'omfield Street, London, E.C.2.

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RECORD

OHMMETER



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Weight UNDER 12 lbs.

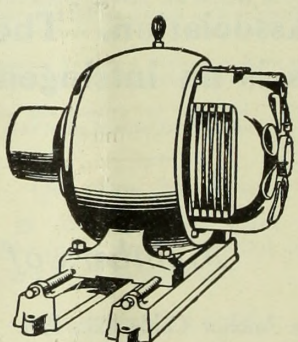
A TRUE OHMMETER—NOT A VOLTMETER CALIBRATED IN OHMS.

500 VOLT GENERATOR

Scale Zero to Infinity, with clear readings from 10,000 Ohms to 100 Megohms

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Record Electrical Co., Ltd.
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BROADHEATH, MANCHESTER.
Phone—Altrincham 164. *Grams—Infusion, Altrincha*

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TO OUR READERS.

ELECTRICITY is published every Friday, and, if ordered, is on sale at the principal Railway Station Bookstalls and Newsagents on that day. It has a very large sale throughout the United Kingdom, as well as in the British Colonies and Abroad.

New advertisements for the displayed columns and alterations to existing ones must reach the publishing office not later than first post Tuesday morning, in order to be in time for the issue of the following Friday. This is important. Rate quoted on application. Subscription: 13s. a year, 6s. 6d. half year, 3s. 3d. a quarter in advance, postage prepaid in the United Kingdom and abroad.

Questions to which an answer is required must be accompanied by a 1½d. stamp for reply. When considered of sufficient interest, the answer will probably appear in the paper.

All remittances payable to the Publishers, S. RENTELL AND CO., LTD., 36-39, Maiden Lane, London, W.C.2. Telephone No. 2460 Gerrard.

Current Topics.

C.O.D.

It may not be generally known to my readers that a Post Office "Cash on Delivery" system has obtained for some considerable time past in connection with certain British colonies and dependencies under which it is possible to consign small goods of limited value to these destinations, leaving it to the postal authorities to collect and remit the purchase price. One of our advertisers recently received a small order for goods from Ceylon, the client specifying this system of payment, viz., C.O.D. Our trader friend duly studied his Post Office Guide, and meticulously followed the simple directions therein given, packing and marking the goods as specified, and calculating what is known as the "Trade Charge." When duly ready for the post, the fun began; the parcel was presented at a sub-Post Office in an important provincial city, but the staff there knew nothing about the mysteries of C.O.D., and recourse was had to service instructions. After much consultation of dusty official literature and considerable delay, the requisite receipt forms were duly made out and the parcel accepted for delivery, the charges being paid by the sender.

This preliminary formality occupied something like forty minutes of the messenger's time, and had he been less intelligent and persistent that parcel might have been awaiting attention even as I write these lines. However, the staff admitted that it was the first case of its kind they had had, and acknowledged that they were ignorant of the precedure, but were nevertheless pleased at the opportunity to learn their business. So far, so good; the package duly started on its journey, was delivered in Ceylon, the cash evidently collected, and in due course, after a reasonable mailing period had elapsed, the sender received a species of money order for the amount to which he was entitled. Again in search of experience in these matters he duly presented his credit note at the same Post Office which had taken in the goods and issued the receipt therefor. Once more the staff (five in number) were nonplussed; to be called upon for information *re* the sending of a parcel abroad C.O.D. was one thing, and they had duly mastered it, but to be expected to hand over cash on another kind of official looking document was another pair of shoes.

Again the musty rule books, official encyclopædias, etc., were consulted, but without revealing the truth. Even the postmistress was caught guessing, and, in short, nobody behind that counter knew exactly what to do about it. They hesitated to pay over the money, quite a nominal figure, because they had no associated heading on their debit statements to enter it under, and, after some three-quarters of an hour spent in discussing the situation, the trader suggested an application to head office by telephone. That did it; the reply was prompt and to the point; the money order had to be presented through a bank, and so the situation was saved. Although not strictly an electrical subject, I have thought it desirable to recount this true story as an illustration of how little the rank and file, of provincial Post Offices at all events, know of the complex organisation they serve. It is also news, doubtless, to many of my trade readers that such facilities exist for doing business on a limited scale with certain of our colonies overseas and securing prompt payment.

It is probably because the facility is so little appreciated by the general public that the various Post Offices have had no experience in putting it into operation, and were it more generally known and taken advantage of, the C.O.D. system as applying to foreign or colonial trade would prove of material assistance to the small trader in extending his markets. From the fact that goods are ordered to be sent on this system by customers in Ceylon and elsewhere it is evident that it is more familiar to buyers abroad than it is in the country of its origin. I candidly confess I knew nothing about the applicability of a C.O.D. system overseas until it was brought to my notice by one of our advertisers; evidently ELECTRICITY is read in all parts of the world, since this order came through the medium of its advertising columns. *Verb. sap.*

An Inhuman Task.

According to the Secretary of the Union of Post Office Workers, there is growing dissatisfaction among telephone operators because officialdom has so far refused to set a limit to the load they are individually expected to carry at the switchboard. It is difficult for those who have never visited a busy telephone exchange to appreciate the extremely trying nature of operating service, and to realise what a strain it must be on the nerves of the young ladies at the switchboard. According to the above official the present tendency is to overload the operators by giving them too many subscribers to attend to. To quote from an interview with a reporter—"A telephone girl cannot possibly give proper attention to the calls she receives at present. Many of the girls are exhausted at the end of their day's work. Sometimes a girl is required to work at full speed for nine hours. The Post Office takes little account of the human element, and telephonists have to go on very much like machines."

Having had personal experience of the physical, nervous and mental strain of operating during the regime of the late National Telephone Company, my sympathy goes out to those overworked operators. Many years ago I was responsible for the operating service in a certain important exchange, which shall be nameless. It was in the days of the "call-wire" junction, and I do not exaggerate when I say that it was quite a common, almost daily, occurrence for the junction wire operator to subside in hysterics during the "busy hour" and have to be temporarily replaced by a relief operator. Modern switchboard service is quite as exacting, if not more so. Not only is it deadly

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monotonous, but it entails such rapidity of movement and quickness of brain to assimilate the multitudinous instructions given in rapid succession by hundreds of different voices that it has always surprised me that telephone operators enjoy as a whole comparatively good health.

It is, however, an evil which must be faced, and the remedy is already at hand, and has been available for the past ten years or more, viz., automatic switching. Time and again officialdom has been urged, nay, entreated, to get on with the job of converting the principal London and provincial exchanges to automatic working. Telephone switching is not a job for human beings; it is essentially a duty which can be performed with mechanical precision by means of electromagnetic switches far more rapidly, accurately, and without the wear and strain on the human anatomy which prevails under the present system. Increasing the number of operators at present on duty will simply alleviate and not remove the trouble, but increase the cost of telephoning. It is too costly now in this country, and we want to decrease rather than add to the cost of communicating by wire. Automatic exchanges will enable us to do this, and at the same time relieve the operating staffs of a duty for which Nature never intended them.

R.I.P.

If one may judge in terms of the time occupied by the special Broadcasting Committee in its deliberations, the new pastime looks like languishing, or even dying an unnatural death, long before the start of next winter. For many weeks now the Committee has been sitting and, apparently, seeking a way out of all the difficulties alleged to stand in the way of progress of the new and once popular science. One week the report is said to be almost immediately forthcoming and interested parties sit up and take notice, only to have their hopes dashed by a bald announcement the week following that fresh difficulties have cropped up for consideration. All through the summer, trade in wireless equipment has been practically at a standstill, and apparently the only people interested in the continuance of broadcasting are those who already possess apparatus purchased during the boom and before officialdom set about killing the proverbial goose. One begins to wonder how many more Postmasters-General will successively occupy the chair of office before that notorious report is actually forthcoming.

Elektron.

E.D.A. AND THE B.E.X.

The plans of the Electrical Development Association for a combined display on behalf of the Electric Supply Industry are maturing rapidly.

A large number of undertakings, both municipal and company, have now made provision to support this work. Recent additions to the list show widespread interest and a desire to be represented, even amongst the smaller enterprises, and bear their full share according to the scales agreed upon.

The management of the enterprise will be primarily a matter for the supporters. The suppliers of electricity, and the example already set is proving most useful in deciding others and enabling the E.D.A. to secure the help needed to produce a valuable and business getting display.

ELECTRICAL ENGINEERING—FINAL GRADE.

Solutions to 1923 Examination Questions of the City and Guilds Institute.

By Edward Hughes, B.Sc. (Eng.) A.M.I.E.E.

(*Continued from page* 422).

Q. 4.—In a 3-phase system containing fifth and seventh harmonics in the pressure waves, prove that, with respect to the fundamental, the seventh harmonic has the same and the fifth the opposite cyclic rotation in the phases.

Apply this to explain the blackening of the commutator at six places in each pole-pair of a rotary converter fed from such a pressure.

A. 4.—Let E_1, E_5 and E_7 be the maximum values of the fundamental, 5th and 7th harmonics e.m.fs respectively. If the instantaneous value of the e.m.f. in the first phase be given by—

$$e_A = E_1 \sin \theta + E_5 \sin 5\ (\theta - \phi_1) + E_7 \sin 7\ (\theta - \phi_2)$$

where ϕ_1 and ϕ_2 are the angles of lag of the 5th and 7th harmonics behind the fundamental, then the instantaneous values of the e.m.fs in the other two phases are given by—

$$e_B = E_1 \sin (\theta - 120^\circ) + E_5 \sin 5\ (\theta - \phi_1 - 120^\circ) + E_7 \sin 7\ (\theta - \phi_2 - 120^\circ)$$

$$\text{and } e_C = E_1 \sin (\theta - 240^\circ) + E_5 \sin 5\ (\theta - \phi_1 - 240^\circ) + E_7 \sin 7\ (\theta - \phi_2 - 240^\circ)$$

$$\text{But } \sin 5\ (\theta - \phi_1 - 120^\circ) = \sin \{5(\theta - \phi_1) - 600^\circ\} = \sin \{5(\theta - \phi_1) - 240^\circ\}$$

since $\sin (\alpha - 360^\circ \times n) = \sin \alpha$

where α is any angle and n is any integer.

$$\text{Similarly } \sin 7\ (\theta - \phi_2 - 120^\circ) = \sin \{7\ (\theta - \phi_2) - 840^\circ\} = \sin \{7\ (\theta - \phi_2) - 120^\circ\}$$

$$\text{Also } \sin 5\ (\theta - \phi_1 - 240^\circ) = \sin \{5\ (\theta - \phi_1) - 1200^\circ\} = \sin \{5\ (\theta - \phi_1) - 120^\circ\}$$

$$\text{and } \sin 7\ (\theta - \phi_2 - 240^\circ) = \sin \{7\ (\theta - \phi_2) - 1680^\circ\} = \sin \{7\ (\theta - \phi_2) - 240^\circ\}$$

Hence we can now write the instantaneous values :—

$$e_A = E_1 \sin \theta + E_5 \sin 5(\theta - \phi_1) + E_7 \sin 7\ (\theta - \phi_2)$$

$$e_B = E_1 \sin (\theta - 120^\circ) + E_5 \sin \{5\ (\theta - \phi_1) - 240^\circ\} + E_7 \sin \{7\ (\theta - \phi_2) - 120^\circ\}$$

$$\text{and } e_C = E_1 \sin (\theta - 240^\circ) + E_5 \sin \{5\ (\theta - \phi_1) - 120^\circ\} + E_7 \sin \{7\ (\theta - \phi_2) - 240^\circ\}$$

Comparison of the above expressions shows that the 7th harmonic in the second phase lags 120° (electrical) or $\frac{1}{3}$ of its cycle behind the corresponding harmonic in the first phase, and that the 7th harmonic in the third phase lags by another $\frac{1}{3}$ of a cycle; hence the vectors for the 7th harmonic voltages rotate in the same direction as those for the fundamental voltages.

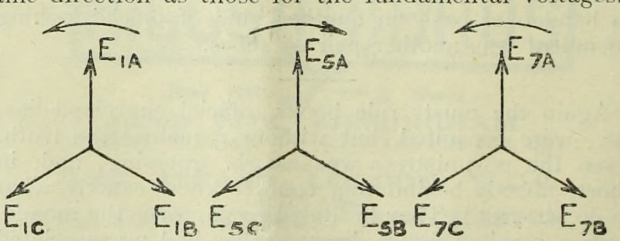


Fig. 4.

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These vectors are shown in Fig. 4, where the suffixes *A*, *B* and *C* refer to the three phases.

With the 5th harmonics, on the other hand, the voltage that is lagging $\frac{1}{3}$ of its cycle behind the 5th harmonic voltage of phase *A* is that of phase *C*, whilst that of phase *B* is lagging by another $\frac{1}{3}$ of a cycle. Consequently, the sequence of the 5th harmonic voltages is—E_{5A}, E_{5C}, E_{5B}; so that the vectors for these voltages rotate in the opposite direction to those for the fundamental voltages.

When a rotary converter is fed from an A.C. supply containing either a 5th or a 7th harmonic or both in the e.m.f. wave, a ripple of 6 times the fundamental frequency is produced on the D.C. voltage wave. To illustrate this point, the writer has taken a number of oscillograms for a 3-phase rotary converter fed from an alternator having a 5th harmonic in its voltage wave. Thus in Fig. 5 curve *A* gives the voltage on the D.C. side,

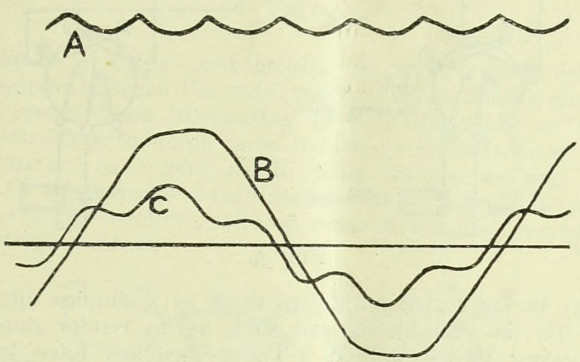


Fig. 5.

the zero line of this voltage being the same as the axis of curve *B* which shows the line voltage of the alternator on *open circuit*. Curve *C* gives the line current taken by the rotary on no-load, and indicates the presence of a distinct 5th harmonic.

The production of a 6th harmonic on the D.C. voltage wave can be explained thus :—

When the armature of a rotary converter is fed from a sinusoidal polyphase supply, a magnetic field is produced which rotates at synchronous speed relatively to the armature, but is stationary relatively to the field-magnet system when the armature is running at synchronous speed.

If a 5th harmonic be introduced into the e.m.f. wave, an additional magnetic field is set up, rotating at 5 times the synchronous speed relatively to the armature. But it has been shown above that the 5th harmonic in a 3-phase system has a cyclic rotation opposite to that of the fundamental, so that relatively to the poles and the D.C. brushes, the magnetic field due to the 5th harmonic rotates at $(5+1)=6$ times the synchronous speed. Hence an alternating e.m.f. of $6\times$ the fundamental frequency is generated between the brushes on the D.C. side, and this e.m.f. superimposed upon the steady D.C. voltage gives us the voltage curve *A* in Fig. 5.

With a 7th harmonic, on the other hand, the magnetic field due to it is rotating in the same direction as that due to the fundamental, but at $7\times$ the synchronous speed relatively to the armature; so that relatively to the poles and the D.C. brushes, this magnetic field is rotating at $(7-1)=6\times$ the synchronous speed. It therefore follows that the magnetic fields due to both the 5th and the 7th harmonics rotate relatively to the D.C. brushes at $6\times$ synchronous speed, but in opposite directions.

Next, let us consider the effects of these rotating fields upon the armature coils short-circuited by the D.C. brushes. When the latter are in the neutral position and the machine is on no-load, there is no reactance voltage ; but the magnetic fields due to the 5th and 7th harmonics induce e.m.fs tending to circulate currents round the local circuits formed by the short-circuited coils and the brushes. These e.m.fs have a frequency of $6\times$ the fundamental frequency (as proved above), and therefore the circulating currents due to them increase to a maximum value (positive and negative) 12 times in the period taken by the armature to rotate through two pole-pitches. Under these conditions we should expect to find blackening of the commutator at 12 places per pole-pair, and not at 6 places as mentioned in question.

In order to confirm this conclusion, the writer removed one of the brush arms of the rotary and took an oscillogram of the voltage between two brass strips bearing on the commutator at a distance apart equal to the width of the main brushes. The curve shown in Fig. 6 was obtained. The ripples on this curve are due partly

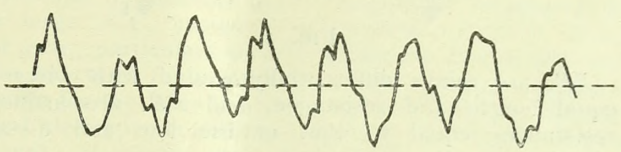


Fig. 6.

to the teeth and partly to the commutator segments of the rotary, and have no bearing upon the subject under discussion. Comparison of this curve with Fig. 5 shows that circulating currents are set up in the short-circuited coils 12 times in every cycle of the fundamental, and therefore there is a tendency for the commutator to blacken at 12 places per pole pair.

If the rotary is on load, or if the brushes are not in the neutral, the conditions are somewhat modified. Thus, if the reactance voltage is either greater or less than the e.m.f. generated by the commutating poles or by the lead or lag of the brushes in non-commutating pole machines, the effect of the resultant voltage is to shift the horizontal axis in Fig. 6 either up or down, and thus to give rise to six peaks of e.m.f. in the short-circuited coils during the period taken by the armature to rotate through two pole-pitches. Under these circumstances, it is possible for blackening of the commutator to occur at six places per pole pair.

The effect of pulsations in the armature reaction of a rotary running on load has not been considered since it does not bear upon the matter referred to in question.

(To be continued.)

University College, London.—A Goldsmid Scholarship, tenable in the Faculty of Engineering, of the value of £120 (£40 a year for three years, subject to satisfactory progress), will be offered for competition at an examination to be held at University College in September. Particulars on application to the Secretary of the College.

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TELEGRAPHY.—GRADE I. (1923).*

Being Solutions to the Questions set by the City and Guilds of London Institute in the Grade I. Examination in Telegraphy held in May, 1923.

(Continued from page 425.)

Q. 9.—Explain the principle of differential duplex working. Give a diagram of a two-station single-current duplex.

A. 9.—Duplex working consists in the simultaneous transmission of messages, one from each end, over a single circuit without mutual interference. Fig. 2 illustrates the principle of the opposition method of differential duplex working.

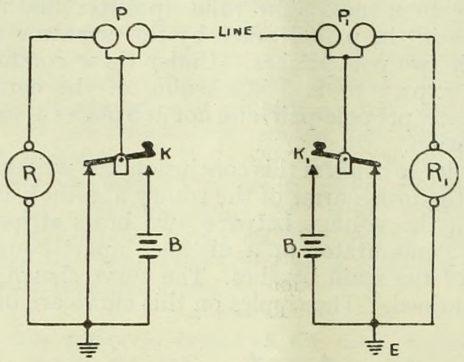


FIG. 2.

PP_1 are relays differentially wound with wires of equal length and resistance, and RR_1 are artificial resistances equal to that of the line and distant apparatus.

When the key at the up-station is depressed, the current divides at P, half passing to the line and half going by way of R. The line current flows through one coil of the relay, through K_1 to earth, and back to the negative pole of the battery B. Since equal currents flow through the coils of the relay in opposite directions, no effect is produced on the home relay, but, as the current traverses only one coil of the relay P_1, a signal is registered.

In the same way, if the key K_1 is depressed, the home relay is unaffected and the relay P is actuated.

When both keys are depressed simultaneously, the currents oppose each other in the line, and *the currents flowing in the compensation circuits operate the relays.* Thus, when both keys are depressed, the relays at each station are actuated by the current in its own compensation circuit *in the same way as if the current from the other station were received.*

It has been assumed that the line and compensation currents are equal, that the batteries oppose each other in the line, and that the current splits once only at either end. In practice, however, the batteries may be connected to act in conjunction (*combination* method), in which the current in the line is double that in each of the compensation currents. Moreover, the current splits twice, viz., at the galvanometer and the relay. This is shown in Fig. 3, which represents in skeleton form a two-station single-current duplex circuit. r and r^1 are resistances inserted in the lead to the back stop of the key at each end, and equal respectively to the internal resistances of the batteries B and B^1. The object of introducing them is to ensure the same conditions as regards the resistance of the line circuit, whether the distant key is at rest or depressed.

Usually on duplex circuits a six-terminal two-position switch is provided at each end, so that the connections

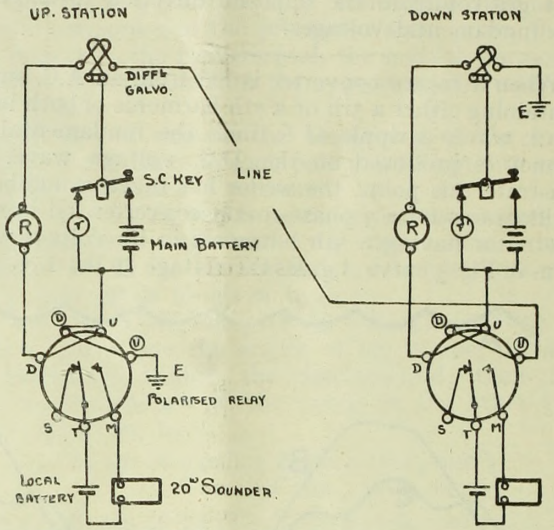


FIG. 3.

may be converted readily to those of a simplex circuit if the line conditions are such as to render duplex working unsatisfactory. These switches have been omitted in Fig. 3 for the sake of clarity.

(To be continued.)

* *The standard text books for this Grade are: "The Telegraphists' Guide," by Bell & Wilson (20th thousand, 3s. 6d. net), and "Questions and Solutions in Telegraphy and Telephony, Grade I.," by Few (5th edition, revised, 5s. 6d. net).*

SINGLE-PHASE COMMUTATOR MOTORS.

THEIR PROGRESS AND REASONS WHY THEY DEMAND THE ATTENTION OF POWER ENGINEERS.*

(Continued from page 425.)

During the starting period, if the rotor circuit is completely open, the machine operates as a pure repulsion motor—that is, it has characteristics similar to those of a D.C. series motor. It is well known that the D.C. series motor, if fitted with a laminated field, will operate on alternating current. In order to describe the transition from such a series motor to the repulsion motor, we may refer to the diagram of Fig. 3. These diagrams show—

TRANSITION FROM D.C. SERIES MOTOR TO REPULSION MOTOR.

(*a*) A plain series motor with the armature directly in series with the field.

(*b*) A neutralised series motor in which slots are made in the pole face, carrying windings which are connected in series with the armature winding, and having such a number of turns that at each point in the pole face the ampere turns due to the neutralising windings are exactly opposite to those in the armature at the same point.

The use of such windings has the effect of preventing the distortion of the field of the D.C. machine

* A Lecture delivered before the N.A.S.E., by F. Creedy, Esq., A.M.I.E.E., A.C.G.I.

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under load, and of improving the commutation in a somewhat similar manner to the effect of interpoles, in fact, such a winding may, in some respects, be regarded as an inter-pole winding, spread over the pole face,

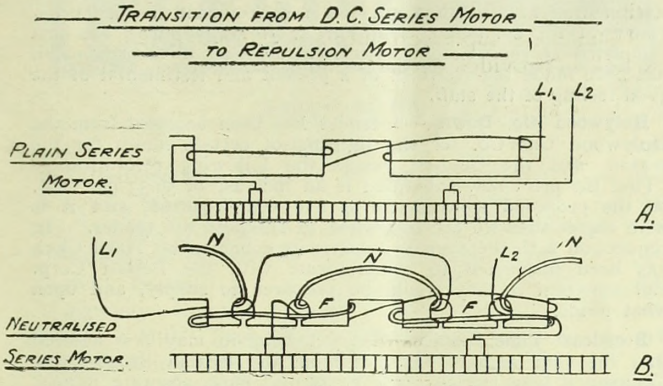


FIG. 3.

instead of being concentrated on an inter-pole intermediate between the main poles. When such a motor is operated on alternating current the effect of this neutralising winding is to reduce the inductance of the armature to a very small value, thereby making the A.C. series motor a very useful machine in certain cases where the machine, without neutralising coil, would be entirely useless.

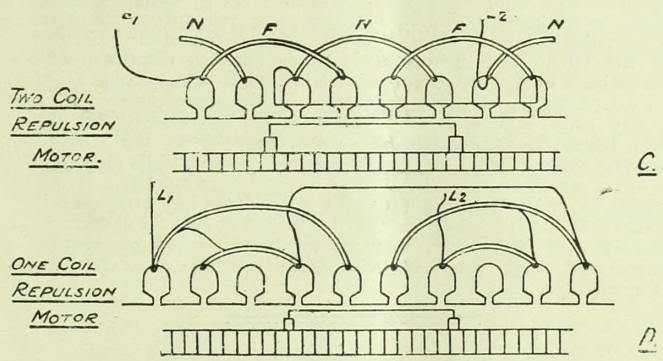


FIG. 4.

The chief defect of the neutralised series motor for use with circuits of normal frequency is the fact that the voltage across the commutator is nearly equal to that across the line. For a motor, therefore, which it is desired to operate at 400 volts, 50 cycles, this would involve absolutely impossible commutating conditions. To overcome this difficulty it is desirable to render the commutator voltage independent of the line voltage by making use of the possibility of voltage transformation in the A.C. circuit. Accordingly, instead of connecting the armature in series with the neutralising winding, we short circuit it, and connect the field and neutralising winding in series across the line, as shown in diagram *C*, Fig. 4. The armature now receives its current by transformation from what was before the neutralising winding, which now acts as primary to the armature as secondary. It is now possible to choose the armature winding to suit the requirements of commutation, without in any way considering the line voltage.

(To be continued.)

Reviews of Books, &c.

[*Books noticed in this column will be sent from* ELECTRICITY *Office to any part of the world, for the published price, plus five per cent. for postage (minimum 2d.), and orders will be appreciated.*]

A.C. PROTECTIVE SYSTEMS AND GEAR. By J. Henderson and C. W. Marshall. 108 pp., 32 figs., 3 tables. (Pitman, 2s. 6d.)—The development and use of gear for the protection of H.T. alternating current systems from the effects of faults is here lucidly and concisely treated from the point of view of the operating engineer. The work is right up-to-date and the suitability and limitations of the various systems so far developed are set forth with the aid of illustrations and diagrams so that this very important, but difficult, question is most readily comprehended. Not only operating engineers and students, but manufacturers should find the information of very considerable value. The whole field is covered, as after detailing the main principles of protection the authors describe the various current-limiting devices and proceed to discuss the automatic protective systems available for large networks. After this, circuit breakers and H.T. fuses are treated, and the action of different relays expounded. Among the most valuable chapters are those at the end, in which the authors give a suggested equipment for a large A.C. system and reasons for their choice of gear; particulars of tests necessary in practice; and the effects of faults on large supply systems. A plea is made for the issue of statements by boards of directors and electricity committees showing the degree of continuity of service they obtain from year to year, and the causes and remedies from any interruptions that occur. Some notes on faults which have occurred in the Glasgow supply system are published by permission, and are of the utmost value as an index of the great progress recently made in strengthening the weak spots.

ELECTRICAL INSULATION. By W. S. Flight, A.M.I.E.E. (Pitman, 2s. 6d. net.)—Like other volumes in this series of primers, a very large amount of information is packed away in a comparatively small compass, as the author is essentially an expert in his subject, so that his information may be considered accurate and up to date, while the addition of a bibliography adds to the value of the book owing to the wide range of references.

Materials are dealt with under various headings, and we should have liked to have seen a little further information upon the various grades of hard rubber or ebonite, and also upon the various grades of rubber insulation connected with cable manufacture. These same remarks also apply to the short paragraphs upon moulded compositions. These occupy a higher position to-day in the electrical industry than they have ever previously held, and are certainly worthy of more attention. We know from experience that Mr. Flight could ably describe such compositions, and we consider that they ought to be a large addition to his book. They have, no doubt, been purposely omitted, and the book written with the express idea of describing insulating materials of the paper, fabric and varnish class. This being the case, then the title of the book is, perhaps,

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a little misleading, and its purchase disappointing to some.

The tendency of the book is to describe insulating materials used on the windings of electrical machinery, and is amply illustrated with diagrams and curves. It is specially recommended to young engineers in any way interested in such machinery, as they do not generally consider in any detail the question of insulating materials from the insulation manufacturer's standpoint.

The book does not fall short of the standard attained by other volumes of this series.

FAR EAST INDUSTRIAL MANUAL.—A reference book of industries in the Orient which are users of machinery has just been issued by the *Far Eastern Review*, of Shanghai. The book is called "Rea's Far Eastern Manual." Besides factories, it includes dockyards and shipbuilders, railways, sawmills, and telephone, waterworks and shipping companies. The volume, which contains more than 1,000 pages of text and a further number devoted to advertising, lists factories in various industries. In many cases, especially of the larger and better-known plants, the manual gives a minute description of the equipment installed. In a section devoted to electric light and power plants, 116 double-column pages are required to list and describe those in the Far East, the list covering plants in China, Japan, Korea, Formosa, the Philippine Islands, the Netherlands East Indies, the Straits Settlements, the Federated and Native Malay States, British North Borneo and Siam. According to the preface, 90 per cent. of the material is from official publications or from other authoritative sources.

Various Items.

Blackpool.—The large new pavilion at the west end of the North Pier, to replace the one destroyed by fire, will be one of the finest concert halls in the kingdom. The electrical installation is being carried out by J. Lomax, Kendall and Co., of Manchester.

Aylesbury.—A small electrical exhibition is being arranged in connection with the official starting-up of the new turbo-alternator about the first week in September. The present tariff is 9d. per unit for the first few units, then 2d., and as this is likely to be reduced substantially in the near future, good business should be effected. Particulars from E.D.A.

Finance.—W. T. Henley's Telegraph Works Co., Ltd., are paying a dividend on the preference shares at the rate of 4½ per cent. per annum on September 1, and an interim dividend on the ordinary shares of 1s. per share, less tax.——The accounts of the Stepney Electricity Undertaking to March 31 last show much better results than were anticipated, owing to a general revival of industry in the borough. The gross profit is £137,066, which is nearly 14 per cent. on the averaged capital expenditure and over 20 per cent. on the balance of outstanding loans. An increase of nearly two million units for power purposes was obtained as compared with the preceding year.

Personal.—Mr. A. H. Jackson has resigned his position as traction representative to the English Electric Co., Ltd., on being appointed sales manager of the Electric Traction Dept. of the General Electric Co., Ltd., Magnet House, Kingsway, London, W.C. 2. Mr. Jackson, who was formerly traction representative to the British Westinghouse Electric and Mfg. Co., Ltd., received his technical training at the Finsbury Technical College, and has had a wide and specialised experience in all branches of electric traction work, having been identified during the last twenty-two years with the Brush Elec. Engng. Co., Ltd., the London Underground Rlys., the British Elec. Traction Co., Ltd., and the L.C.C. Tramways

J. Lyons and Co., Ltd.—The National Society of Supervising Electricians are paying a visit to the new Greenford factory to-morrow, the 18th inst., to inspect particularly the many interesting applications of electricity.

Aldershot Military Power Station.—Colonel A. G. Stevenson, who was officer in charge of electrical machinery when the station was first established, has now returned as chief engineer of the command. Captain A. J. Mayne, who has just completed 25 years as chief electrical engineer to the command, has been made the recipient of a present and testimonial of the good feeling of the staff.

Holywood (Co. Down).—A tender has been accepted from the Holywood Gas Co. for the lighting of certain lamps for the season, and the Council passed the following resolution:—"That the price now submitted is an increase of 56.33 per cent. on the proposed contract for a five years' period, and it is with regret that we are compelled to accepted the tender." In connection with the proposed electricity scheme, the Town Clerk has been instructed to communicate with the Belfast Corp. and ascertain if they would be prepared to supply, and upon what terms.

Broadcast Time Service.—Every Listener-in may rest assured that the time signals sent out from the British Broadcasting Company's new stations will be of the most accurate nature. For some time past the Birmingham station has been equipped with a system of "Pulsynetic" electric clocks supplied by Gent and Co., Ltd. (Faraday Works, Leicester), and now, owing to the unqualified success of this system, it has been decided that the new stations at Aberdeen, Bournemouth and Manchester shall be similarly fitted. Each installation has a master clock, from which the time signal is given, and from the beat of whose pendulum the announcer counts the seconds. In addition, three secondary dials, driven by the master clock, indicate uniform and accurate time in the other important rooms in the station.

Coopers Hill War Memorial Prize.—The foregoing, founded by members of the Royal Indian Engng. College, Coopers Hill, in commemoration of members who fell during the war, is awarded annually by the Inst.C.E. and triennially in turn by the I.E.E., the School of Military Engng., Chatham, and the School of Forestry, Oxford. The prize, which consists of (*a*) a bronze medal, (*b*) a parchment certificate of award, (*c*) a money prize of the value of about £25, is awarded for the best paper on a professional subject selected by the Council making the award. One of the triennial awards falls this year to the Council of the I.E.E. The subject of competitive monographs is, "An Historical and Critical Survey of Atmospheric Electricity and Protection against Lightning." Papers, by corporate members who were under thirty years of age on January 1, 1923, must be submitted to the Secretary by December 31, 1923

Trade Notes.

The British Thomson-Houston Co., Ltd., are making a very special offer of artistic semi-indirect lighting fittings at reduced prices to the trade during the present month. The fittings may be inspected at Mazda House, 77, Upper Thames Street, E.C.4, or at any of the company's provincial showrooms.

Two attractive showcards, measuring 12 in. wide by 10 in. deep, have been issued by the **Hart Accumulator Co., Ltd.**, of Stratford, London, in which are illustrated the various types of "Hart" batteries for radio-wireless work, which are in such large demand for wireless circuits. These cards are printed in three colours, the lettering being white on black, mauve and green background respectively, so as to give a greater variety in any colour scheme which the trade may require. To those interested who have not yet received them, these showcards may be obtained on application to the company. Stocks are held of all the batteries illustrated, ready for immediate delivery at any time both from the Stratford works and the company's branch offices at Birmingham, Manchester, Glasgow and York.

A neat showcard, in blue, white and black, issued by the **Edison Swan Electric Co., Ltd.** (Ponders End, Middlesex), depicts Ediswan wireless apparatus, batteries and valves, and exhorts wireless enthusiasts to "Use Ediswan and hear everything."

A mail card from **Frederick Pratt** (66, Victoria Street, S.W.1) illustrates and prices 25 and 60 amp. at 500 volts Safety Fuses.

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A POPULAR SCIENTIFIC WEEKLY JOURNAL
ELECTRICITY
A PRACTICAL TRADE JOURNAL

AUGUST 24, 1923.

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THE REFRIGERATING PLANT AS AN AID TO BUSINESS.

By James Tyler.

Whilst most of our large towns have provision for ice making and cold storage, yet it may be said without fear of contradiction that the provision might be doubled in each case, without in any way approaching the point at which the capacity of the district to use these conveniences would be exceeded.

In the smaller towns, ranging from, say, 5,000 to 50,000 population, the matter has hardly been touched, and the scope is very considerable.

Both in the large town and the smaller community, the provision or extension of cold storage and ice making should be nursed and encouraged by our industry.

The large town will, perhaps, instal two or three compressors, each demanding 80/90 b.h.p., and one or two smaller auxiliary motors. The smaller towns may not put down a public installation, though this is usually best, but they certainly will, with slight encouragement, yield a good harvest to the enterprising contractor in the matter of small self-contained sets. These latter may only demand from 1½ to 6 b.h.p., are practically automatic in their action, and require little attention.

The load is a most acceptable one to any electricity supply authority, for the following reasons:—

(*a*) The load is practically constant, and it pays to run the plant for ten or twelve hours per day, or throughout the 24 hours if business demands.

(*b*) The greatest demand for ice is in the hot weather, when the demand for lighting is practically non-existent, and in the winter months it can be arranged to run the plant on most days when the peak loads at the works are over.

(*c*) The provision of ice and cold storage is a growing and expanding business; one in demand, and therefore likely to be stable, well to do, and able to meet its accounts with regularity.

The average electrical contractor knows less than nothing about the refrigeration process. Whilst this may be looked on as a drawback, it is by no means an unclimbable obstacle, as any of the leading makers of plants, or consultants in that line, will arrange the installation in such a matter that its working is quite simple and straightforward.

In the larger plants it is necessary to engage a man accustomed to the type of work; whilst in the small individual plants, such as those at hotels, institutions or large meat and provision shops, the plants supplied are sufficiently automatic to run with unskilled attention.

In a small borough of 25,000 inhabitants, having a struggling electricity works, the installation of a public ice factory and cold store would provide, say, a constant 20 horse-power load for ten hours a day in summer, and, say, five hours in winter, during the first year.

In the second year, the benefits to the meat, fruit, fish and poultry trades would have so impressed themselves on the town that extensions would be probable, at first in the matter of longer working hours, and then with further plant.

Perhaps the best way for any interested electrical man to proceed is to sound one or two of the leading tradesmen in his town, point out how they can keep surplus goods over the week-end, carry larger stocks, and be certain of selling them; to-day, such tradesmen dare only carry a small stock, disappoint some customers and lose profit, or lay in a larger stock, risk being left with some of it over the week-end, and being forced to sell at any upset price in order to avoid a total loss on the stuff left over. A cold store obviates this at once; enables the buyer to get better terms by purchasing in larger quantities, and protects him against both loss of trade and loss of stuff. Another feature of such ventures is that the Government and also Municipal authorities are favourably disposed towards such plants, as they assist to render the town proof against being starved out by a railway or transport strike.

The sum required to start such a place is not beyond the leading half-dozen tradesmen in such boroughs; and on many grounds it is preferable to keep the capital of the concern as local as possible.

Take a town of 10,000 inhabitants. Judging by what has been experienced elsewhere, such a town would do well to start up with a plant capable of giving, say, five tons of ice per 20 to 24 hours, and also providing for 6,000 cubic feet of storage. The most up-to-date system is the dry compression method, and this could be put down for about £2,500, exclusive of buildings. The amount would include compressor, condenser (type and cost depends on the local water supply), liquid receiver, and also a complete ice-making plant. This latter is a little job all to itself, complete in every way with ice cans and a small overhead crane running over the top, to facilitate handling the ice and filling up with fresh cans, fans and air coolers, and special ammonia piping. All these features are under the ice plant contract, and the contractor simply has to connect up to the motors and lights. It is, of course, imperative to specify that the plant shall make pure, clear, merchantable block ice.

In the above estimate the motors have been included and would represent about 35 b.h.p. all told, that for the compressor being about 25 b.h.p.

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Building is the most elusive cost to fix in writing an article such as this, because in many towns it is possible to make an old mill or brewery come in for the purpose; the latter, an old brewery, is especially suitable, owing to the fact that a good supply of water for condensing purposes will be on site, a good pure town's water supply laid on, lifts, cold rooms, and various sized rooms and chambers also being ready made and easily adapted to the purpose of an ice factory or cold store. The building must lend itself readily to having the walls insulated for the cold rooms, and for a plant the size now being discussed it will suffice to leave, say, £800 on the estimate for this purpose, and this should be ample. One point to be noted is that the town's water itself must not be unduly acid. This can be considered, however, when the plant is being definitely schemed out, and is not often a source of trouble.

The cost, therefore, of such a scheme would be, say, £3,300, if electrically driven, and including a reasonably good sum for building. This is one advantage of the electrical drive, the capital is very low; also, the space occupied is least of any type of plant, and a good standard medium-speed motor can be used to drive a slow-speed compressor by belt. This makes, perhaps, the most economical type of unit. Also, the electrical method costs least for upkeep, attention, insurance, stores, oil, water and depreciation. The motors, the lighting, and any other electrical services would, of course, fall to the local contractor who had been enterprising enough to initiate such a venture; he would probably be invited to take a seat on the board, owing to his technical electrical knowledge being valuable to the company.

The running expenses would be roughly as follows. Allow the plant to be working 300 days a year, for an average of 20 hours a day, and with current at 2d. a unit purchased.

Allow 30 units per hour as the normal output, and this gives a cost of 600 units, or 1,200 pence, per full working day. Thus, £5 a day, or £1,500 a year represents power charges. Wages, water and stores would bring the cost up by another £600 a year, so that the total yearly expense would be £2,100.

Against this, the plant would sell, say, 1,250 tons of ice during such a working year, at a cost of approximately £3 10s. a ton. It is probable that in a country town the cost per ton of ice now delivered by transport is nearer £5, and this has to be paid for as tonnage at the loading station, not the delivery point. Thus, the price mentioned is conservative enough to be safe.

One thousand, two hundred and fifty tons of ice at £3 10s. a ton represents an income of £4,375 a year, leaving a margin of £2,275. Depreciation of plant at 10 per cent. will absorb £330, and leave £1,945 to be otherwise divided. This is sufficient to reserve a portion and pay 10 per cent. on a capital of £6,000.

Thus, the returns from a well-managed plant, having the chief users of the district as its shareholders, may be very attractive.

Naturally, the above figures can only be approximate, but they are somewhat against the project rather than in its favour.

The load is well worth having to any local electricity supply; one of the best features is that it is possible to put down a duplicate set, and so to run the whole plant at the best possible economy according to the demand. Whilst the efficiency of such small sets is surprisingly high to-day, yet, as in other activities, the larger scale production gives the best possible results. The plant can be started with a five-ton set, and then another similar or larger set installed, or even a two-ton set could be first installed. The matter is elastic to a high degree.

If power is not already on tap, then it might easily be the start of a local power supply; or, if started on its own, could be put down to generate current at below 2d. a unit probably, and should be so laid out that it will be available for connecting to the local supply when that starts its career.

It would be an ideal plan to run both concerns together, as the ice industry would help the electric supply through the summer, and be the nucleus of a really decent load for a small place to start up with.

In any case, the points to be noted by the contractor are, that such plants will come whether he is in at them or not; if he is in at them, so much the better for him. Such plants are also always likely to extend, as it is found that many classes of provisions are the better for being kept at a level temperature than stored without this precaution.

Thus, besides the initial work, the enterprising electrical man who helps along such a venture stands to obtain a really good and constant customer. In short, the work is there, almost for picking up.

N.A.S.E. SCHOLARSHIPS.

The National Assocn. of Supervising Electricians, 82, Victoria Street, S.W.1, announce a scheme of scholarship exhibitions open to their members. This is an active translation of their general policy on education, which rightly recognises that the work of the skilled foreman and supervisor gets more and more complicated each day with the advent of new inventions. A complete theoretical knowledge is as indispensable as a thorough knowledge of the practical side of the industry, and it is incumbent on the Association to encourage and assist its members in obtaining such advantages.

With this end in view, the Board of Control have decided to make a commencement with the following scheme :—

Three scholarships are to be offered, one for members under 23 years of age, and two for those above that age.

The scholarships will be tenable anywhere, subject to the approval of the Assocn.

In the case of those under 23 years of age, the scholarship will be of the value of £6, payable 30s. per annum for three years, and 10s. per annum for books.

The two scholarships for seniors are of the value of £7 each, payable £2 per annum for three years, and £1 for books.

To enable successful candidates to take advantage of this year's sessions, which commence in September next, the prizes will be awarded by a Special Selection Committee. Applications are to be sent to the General

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Secretary of the Association, not later than the 30th inst., giving replies to the following questions :—

1. Why I think I should be awarded this scholarship.
2. Present occupation and positions held.
3. Particulars of experience to date.
4. (To be answered by juniors only). Particulars of general education.

Such a scheme as outlined is naturally imperfect in its details at the commencement, and it is hoped that this will only be the beginning of something larger in the future. Seeing that the project was only mooted in July by the President, Mr. W. E. Highfield, M.I.E.E., it is creditable that a concrete scheme has been already launched.

THE SHIPPING, ENGINEERING AND MACHINERY EXHIBITION.

The latest bulletin issued in connection with this Exhibition, printed in English, French and Spanish, has been circulated very largely abroad, as well as at home, and shows the wide range of interests to be represented at the Olympia display from August 31 to September 22. There is a list of some forty institutions which are to pay official visits, and these functions will afford three weeks' exchange of courtesies between British manufacturers and potential customers from overseas. Members of the Honorary Committee of Experts will act as guides to parties during the run of the Exhibition. A glance through this bulletin is sufficient to show the world-wide value of this Exhibition, for exhibits applicable to shipping and every form of engineering specially applied to overseas as well as home use are very numerous. It is confidently expected that the visits of Admiralty officials, port, dock and harbour authorities, steamship owners, railway officials, British consuls, construction engineers, from nearly every country in the world, will provide a much needed stimulus to British trade.

OUTDOOR WIRELESS DEMONSTRATIONS.

The ease and speed with which outdoor broadcasting demonstrations can be arranged at almost a moment's notice is clearly exemplified in two photographs of "Gecophone" demonstrations recently brought to our notice.

The first shows a char-a-banc belonging to the fleet of the City of Oxford Motor Services, Ltd., which was equipped for a journey to London and back with a complete wireless installation. It was late on Saturday evening, May 19, when the Oxford Wireless Telephony Co., Ltd., were instructed by the City of Oxford Motor Services, Ltd., to prepare the char-a-banc for its trip on Monday. In spite of the very short notice, a battleship type aerial was erected on the vehicle within a few hours, this stretching from the front of the bonnet to the extreme rear of the car. The earth connection was made to the magneto switch, and the magneto itself was provided with a lead screen which completely enveloped it. The set used was a "Gecophone" 2-valve receiving set, and a loud speaking equipment was also included. By 11 o'clock on Sunday morning the whole outfit was ready for the road, and a practical test was made when broadcasting commenced at 8.30 p.m.

The char-a-banc was driven as far as Stabhampton village, where the inhabitants listened with appreciation to the magnificent choir of St. Stephen's singing an anthem, musical selections by the Highgate Silver Band, and a sermon by Bishop Taylor-Smith.

On Monday morning the char-a-banc started for London, but no wireless could be received until the evening as the broadcasting station was not in operation. During the afternoon the char-a-banc was parked outside the Zoological Society's Gardens at Regent's Park, and at 5.30 p.m. the children's stories were received and transmitted to a large audience by means of the loud-speaker. On the return journey the adult programme was switched on at 7 o'clock, and at Maidenhead the char-a-banc stopped outside the Dumb Bell Hotel, where another audience collected and expressed their appreciation. At Henley another stop was made at 9 p.m. to allow the story of the opera "Aïda" to be heard by the passengers. The vehicle started on the last stage of its journey to Oxford just as the London Station switched over to Covent Garden, and the passengers were able to hear the opera the whole of the way back. No interference whatever was occasioned by the magneto owing to the efficiency of the lead casing already referred to.

In the second instance a stand was used to give public demonstrations of wireless at the annual Rose Queen and Pageant recently organised at Stretford in aid of the Stretford War Memorial and Nursing Fund and the Lord Mayor of Manchester's Two Million Shilling Fund for the Manchester Hospital. This demonstration, too, was arranged at very short notice, the final consignment of apparatus not reaching the ground until seven minutes past four in the evening. By twenty past four everything was in readiness and the music in full progress. A standard "Gecophone" 2-valve set with loud-speaker equipment was used for the main demonstration, and every note and word was distinctly heard over an area of 125 yards radius. This demonstration was organised by Mr. Charles Cooper, electrical engineer and contractor, of 36, King Street, Stretford, Manchester, and experienced amateurs who were present have stated that never before have they heard wireless transmission so perfectly reproduced.

"MARCONI" VALVES.

As recently announced in our advertisement pages, the G.E.C. have been able to effect a very material reduction in the prices of Marconi valves, types "R" and "D.E.R." This highly satisfactory state of affairs, we are advised, has been made possible by the increased demand for these valves and by improved manufacturing processes resulting in a reduction in the cost of production. These reductions will undoubtedly have a far-reaching effect on wireless trading, and they are none the less welcome coming at a time when the business is suffering from a certain amount of depression. We have always been of the opinion that even at the original price the "D.E.R." low-temperature valve was worth while by reason of its very long life and the small battery power it demands, but at the reduced price these advantages are multiplied many times. In addition, the valves are markedly free in operation from scratching and other parasite noises.

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Questions and Answers by Practical Men.

RULES.

Questions: *We invite our readers to send us questions, preferably on technical problems that have arisen in actual practice. Questions which we consider of sufficient interest to our readers will either be replied to under "Answers to Correspondents" or replies will be invited from our readers. One shilling will be paid for the question which we select for competitive replies in this column.*

Answers: *A fee of 10s. will be paid for the answer which we consider shows the greatest merit, and 5s. for the one we select as second best. In judging the replies, importance will be attached to clearness and conciseness, as well as accuracy. The Editor reserves the right to make no award, or to accept only one reply, if, in his opinion, the answers received do not possess sufficient merit. Competitors desiring the return of their manuscripts, if unaccepted, should enclose stamped addressed envelope.*

Write on one side of the paper only, and if diagrams are sent, draw them on a separate sheet of paper attached to the manuscript. Competitors may adopt a "nom de plume," but, both in the case of questions and answers, the competitor's real name and address must be sent with the manuscript as a guarantee of good faith. No correspondence will be entered into with regard to successful replies. The Editor's decision is final.

Commencing with Question No. 101, a Diploma of Merit will be awarded to the six competitors who win the first or second prize the most times during the next twelve months.

The words "Questions and Answers" or "Q" and "A" should be placed at the top left-hand corner of all letters intended for this column.

Question No. 165.

I hear that in America they have an instrument known as a foot-candle meter. What is this for, and how does it work?—"Wireman."

Question No. 166.

Can any reader give me details of a good electrical fire alarm system? I wish to instal it in a small workshop where the temperature is always varying owing to the intermittent use of a muffle furnace.—"Turner."

(*Replies to Questions Nos. 165 and 166 must be received not later than August 25, 1923.*)

Answers to Questions.

Question No. 161.

Are there any hard and fast rules for the earthing of motors? The other day one of my motors, 10 b.h.p., 440 volts D.C. 3-wire, developed an earth. To my surprise, the earth wire, connected from the motor to the conduit, fused. This wire was about $\frac{1}{8}$ in. copper. As this was evidently not strong enough, what wire should be used?—"Examiner."

Replies to Question No. 161.

The first prize (10s.) has been awarded to "E. M. F." for the following reply:—

In reply to "Examiner's" question, the Institution of Electrical Engineers, in their wiring rules, which should always be observed when carrying out installation work, state (Rule No. 34) that "Earthing conductors (earth wires) must be of copper of a cross sectional area not less than that of a No. 14 s.w.g. . . One such No. 14 s.w.g. conductor for every 50 amperes of working current or part thereof, or a conductor of equivalent cross sectional area shall be used."

Since the full-load current of a 10-h.p. 460-volt direct-current motor is well under 50 amperes, and a copper wire $\frac{1}{8}$ in. in diameter is much thicker than the No. 14 s.w.g. laid down in the rules, one must look for some cause, other than the cross sectional area of the earthing wire, for the burn-out.

Now, in order to protect the motor from damage due to heavy currents flowing either on account of overload or faulty insulation, a pair of fuses, or a double-pole circuit-breaker, should be inserted between the source of supply and the motor, and they should be proportioned to cut off current when, say, not more than 150 per cent. to 200 per cent. of the normal full load current is flowing. The normal full-load current of an ordinary commercial 10-h.p. 460-volt direct-current motor would be about 18 amperes, so that the fuses or circuit breaker should open the circuit when 27 to 36 amperes is flowing.

Any current which passes to earth via the motor frame and earth wire must pass through the fuses or circuit breaker first, consequently an earth current of 36 amperes would cause current to be cut off from the motor if everything were in order.

The question then arises: "What current is required to fuse a $\frac{1}{8}$ in. diameter copper wire?" and the answer, obtained from any reliable table of fusing currents, is in the neighbourhood of 400 amperes.

It is clear, therefore, that a current many times greater than the full-load current of the machine must have passed through the protective gear and earth wire, hence the motor is either—

(*a*) Not provided with suitable overload protective gear, or

(*b*) If overload protective gear is installed it is not working properly.

If (*a*) is the case, the remedy is, of course, to provide suitable gear forthwith.

If (*b*) is the case, and the protective gear takes the form of fuses, the fuse wire should be replaced by a smaller wire calculated to blow at 150 per cent. to 200 per cent. of the full-load current of the motor, according to the class of load.

If the protective gear is a circuit breaker the settings should be adjusted to trip at the currents mentioned in the preceding paragraph, and the breaker should be tested to ascertain that it does actually trip at the predetermined current. Care should also be taken to see that all moving parts are free from any tendency to stick.

Circuit breakers for direct-current systems are sometimes fitted with one overload release only. This is quite sufficient if the system is purely a two-wire system, but if it is three-wire, two overload releases are necessary on a circuit breaker controlling the two outer wires.

If "Examiner's" motor is protected by a double-pole circuit breaker and the system of supply is 460/230 volts direct current three-wire, I would advise him to see that his circuit breaker has an overload release on each pole.

If only one overload release is provided his breaker might be set and working correctly, but an earth on the side unprotected by an overload release would not trip the breaker, and so a current high enough to burn out the earth wire would be allowed to pass. This is assuming what is almost invariably the case, viz., the middle wire is earthed at the station.—"E. M. F."

The Second Prize Winner's reply will be published in due course.

B.E.X., 1924.—We have received from the Board of the British Empire Exhibition a copy of the list of exhibitors in the Shipbuilding, Marine, Mechanical and General Engineering Section of the Exhibition, which is being organised by the British Engineers' Association. Already 276 firms, occupying 203 stands, are represented in this section, which is the largest number of exhibitors in any single industry ever seen in any one exhibition.

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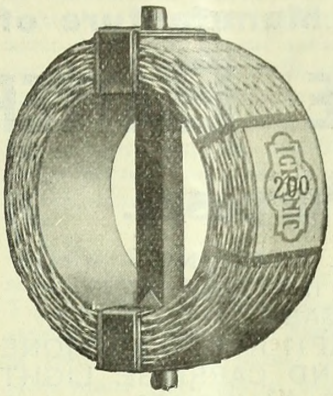
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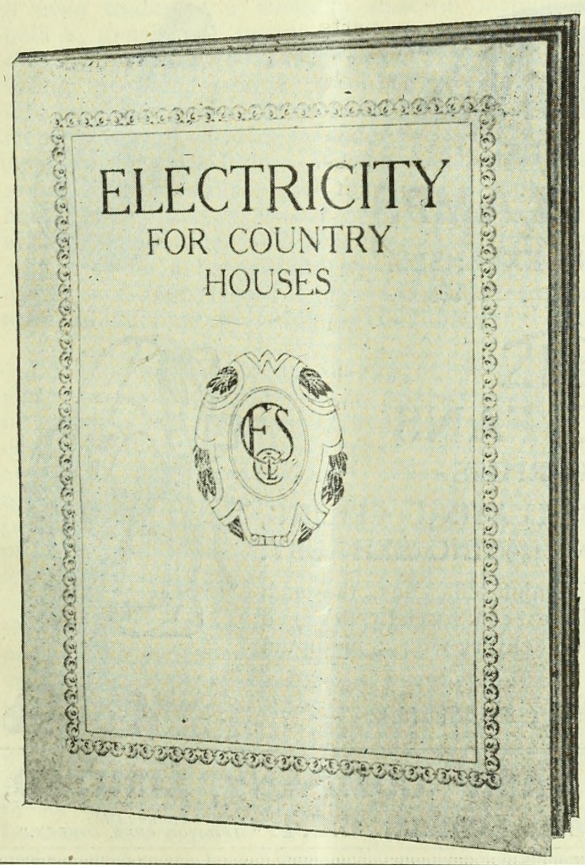
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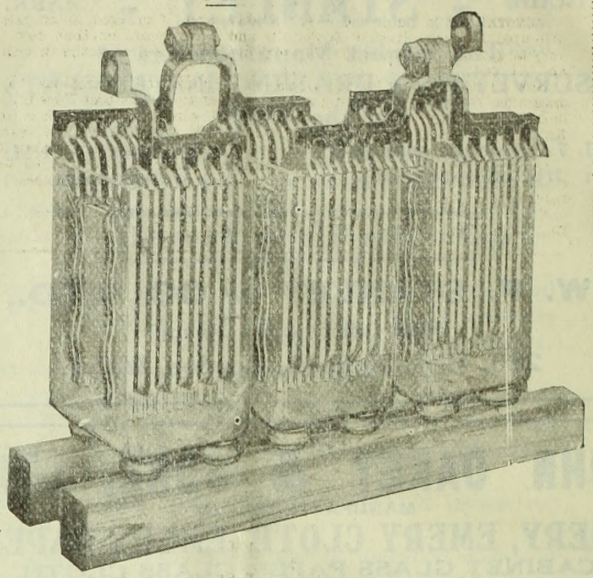
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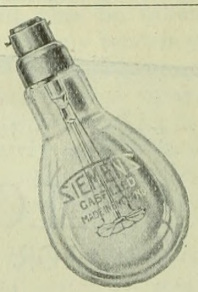
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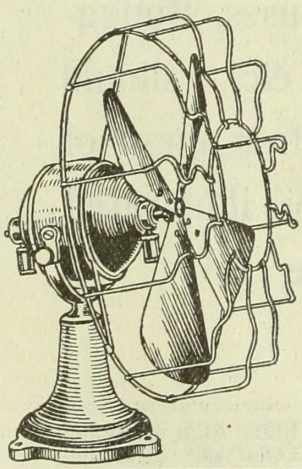
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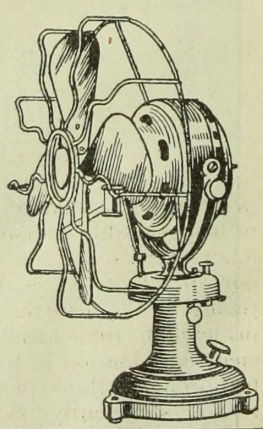


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Current Topics.

Light.

The recent announcement, widely circulated in the lay Press, that an American chemist has discovered a radio-active light in liquid form which can be poured into a bulb, and will last for many years, prompts the reflection how little we know, even in these enlightened days of scentific progress, about light itself. We are all of us familiar in a general way with daylight, the natural illumination derived from the sun, just as we are conversant, in a popular sense, with what we term "electric light," "gas light," or the light derived from oil lamps and candles. We even speak loosely of the term—light—e.g., "Look at the electric light; isn't it brilliant?" Now light, as every modern school-boy is taught, is in itself invisible, but possesses the capacity of rendering visible the various objects upon which it is allowed to fall.

Again, with advancing civilisation, what complex processes we adopt to procure artificial light. We take coal, a natural product, the result of goodness knows how many thousands of years' natural processes, burn it even to-day in a woefully wasteful fashion under boilers, generating steam, which in its turn is passed through turbines; these machines drive dynamos, generating electrical energy, which again is retranslated into heat energy for the purpose of raising a thin filament to a high state of incandescence, and that glowing filament emits light. What a round-about way of arriving at a simple goal. Yet we cannot do any better having regard to our present knowledge of the art of illumination. On the face of it, there would appear to be a far simpler way of storing the sun's energy and reproducing it after sunset for purposes of artificial illumination if only we could master the secret.

Looking back over the history of electric lighting since the first electric light was produced with the aid of batteries and opposing carbon electrodes, I am inclined to think that our men of science, inventors, engineers, and allied workers follow the leader too meticulously; the pioneer discoverer of a fundamental principle, like that of the capacity of electrical energy of being readily transformed into heat and light energy, sets in motion a train of thought which spreads throughout an interested section of the community who apply themselves to a further exploitation of that fundamental principle to the exclusion of all else. There is not sufficient imagination in the average scientist's mind; he is too prone to think in terms of one idea. He does not reason sufficiently on an elementary basis; does not hark back occasionally to the starting point and ask himself whether there is not some alternative method of solving a given problem to that which has already become stereotyped.

Personally I am of the opinion, although I shall probably not live to see it, that the ultimate solution of the problem of artificial lighting will be solved by some ridicuously simple process of direct storage of the light energy of the sun during the hours of daylight. The principle exists to-day, has been known for years; in fact, in the shape of luminous paint, a layer of radio-active matter which, exposed to direct sunlight, has the property of glowing in a visible manner after dark, but in our present knowledge of its properties, does not emit sufficient light to be of any practical service, except for certain minor uses. Radium, again, with its wonderful properties, affords a fascinating glimpse into the possibilities of the future when its properties and those of radio-active substances are better understood.

Again, I urge that we neglect the fundamental sciences in our restless pursuit of the unattainable. Take modern wireless telephony, and the wonderful strides which have been made in perfecting this method of communicating music and speech to a distance. How many devotees of broadcasting have taken the trouble to study anew the fundamental principles of sound, or "acoustics," as it was known in my school days? It is in reality a very complex and fascinating science, whose first principles are almost entirely ignored or overlooked by the designers of sound reproducing devices. Hark back to Phillip Reis's early telephone receiver and consider how he set about producing a colourable imitation of the complex mechanism of the human ear; compare his forethought and inferential reasoning with that of the present-day designer of a wireless receiver or loud-speaker.

No, we are plagiarists, imitators, slavishly following a fashion set by earlier discoverers of a new principle, and although it cannot be denied that wonderful progress has been made in the development of these primary ideas, and that very clever brain work has been evidenced in that development, true originality is nevertheless sadly lacking. All of which serves to emphasise the vital importance of original research. We cannot devote too much attention to the importance of this line of work. What is more, we want to breed a race of research workers, trained in thinking along original lines, working along original lines, and not becoming wedded to an idea at any early stage in their laboratory experience. Research calls for active and untrammelled brain work, free from tiresome routine, or too close and intimate an association with the advancement of a single idea or chain of ideas. Change of work from time to time, according to the temperament of the individual, should go far towards preventing the natural tendency to follow one line of thought, allow the brain to get into a groove as it were.

Industry and the Dole.

It is to be hoped that the Parliamentary Committee which is considering the pressing problem of unemployment during the coming winter will succeed in framing a programme of activity which will prove acceptable to the House as a whole, and enable some of the many thousands now subsisting on the dole to be usefully employed on real productive work. There is no more soul-destroying influence than lack of occupation, coupled with the knowledge that although one is out of a job a beneficent Nation will

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not permit starvation, but will even maintain the idler in comparative comfort, leaving him to while away his time as seems best to himself or herself. The dole system has had a most pernicious influence on the life of the Nation; it has converted temporary unemployed into chronic idlers by the hundred, and, once a man or woman allows himself or herself to degenerate into such a state of mind, it takes time and powerful influences to bring about the reverse process of conversion into useful units of an industrial organisation.

The iniquitous dole is responsible for a goodly proportion of our present burden of taxation, which, in its turn, reacts on the costs of production of practically every class of manufacture. The more we can do to provide useful employment for those at present drawing the dole, the better for the country as a whole. It is far preferable to spend a million of the public money on real productive work, than to present that same million as a free gift to some hundreds of the population for doing nothing and doing it aimlessly. In this connection the projected electrification programme referred to in my notes a week or two back is full of promise for the future, but matters must be speeded up if we are to get the wheels revolving in time to deal with the winter unemployment problem. We are now entering upon the autumn, and there is much to be done before large bodies of men can be engaged on some of the contracts which are at present in contemplation emerge from the "consideration" stage. Let us get on with the job as quickly as possible.

"Electricity" at Olympia.

In our issue of August 3, I referred to the Engineering, Machinery and Shipbuilding Exhibition, which will be held at Olympia from August 31 to September 22 inclusive, and mentioned that it was being supported by a number of the most important firms in the electrical industry, as well as by manufacturers of internal combustion engines for electric lighting, motor boats, etc. Wireless apparatus will also be well to the fore, so the Exhibition will appeal to practically every class of electrical engineer, and naturally I want to hear that there has been a very large attendance of my readers. They are sure to have a good time, and, in order to help towards that end, the proprietors of this paper (S. Rentell and Co., Ltd.) are willing to present a ticket of admission to everyone who posts them an order for a book or books value 2s. 6d., exclusive of postage. This announcement is being made in the advertisement columns of this issue, but I repeat it here, because I want every reader to make the offer as widely known as possible. Then, when you are there, come and see us at Stand 4, Row A, close to the main entrance. You will be welcome.

A Hopeful Sign.

It is a pleasure to note that, according to the official organ of the E.T.U., the electrical trade is showing signs of steady improvement, and there are larger loads generally on the central stations. Unemployment is still abnormal and likely to remain so for a considerable time; but, after all, it is better to "talk happiness" than to be too pessimistic, and, as there is harmony between employers and trade unions so far as our industry is concerned, I hope that all firms having contracts to place will give them out with the least possible delay. Prices are now far more stable, and a steady volume of work would be of untold value to electrical engineers in particular, as well as to the country as a whole.

Elektron.

TELEGRAPHY.—GRADE I. (1923).*

Being Solutions to the Questions set by the City and Guilds of London Institute in the Grade I. Examination in Telegraphy held in May, 1923.

(*Continued from page 436.*)

Q. 10.—Describe, with a diagram, the single-needle instrument. What do you mean by double-current working? Is the single needle worked on the double-current system?

A. 10.—In the single-needle system of telegraphy a code of signals based upon the Morse code is used; the dots and dashes, however, do not differ in length, but are distinguished from each other by the direction of the deflection of a magnetic needle, a deflection to the left representing a dot and a deflection to the right a dash.

For the reception of signals a galvanometer similar to the ordinary single-current galvanometer is used. The reversals of current required when signalling is effected by means of a commutator, which consists of two tapper keys. Each key is of wood, and has a metallic extension at the back end which moves between two contacts. Fixed to each wooden key in front of the bearing is a contact screw, which makes connection with the negative pole of the battery when the key is depressed. The commutator has six terminals, and the internal connections made by the keys in various positions are given in Fig. 4.

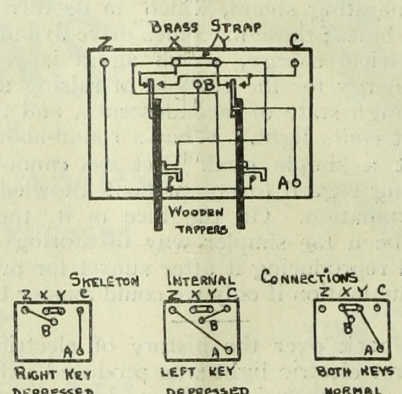


Fig. 4.

The connections of a circuit are shown in Fig. 5, in which the left-hand tapper at the up-station is assumed to be depressed. This corresponds to sending a dot, and the direction and path of the current are shown by the arrows. If the right-hand tapper at the up-station is depressed, as is required for sending a dash, the positive pole is put to earth and the negative pole of the battery to line, thus the direction of the

* *The standard text books for this Grade are: "The Telegraphists' Guide," by Bell & Wilson (20th thousand, 3s. 6d. net), and "Questions and Solutions in Telegraphy and Telephony, Grade I.," by Few (5th edition, revised, 5s. 6d. net).*

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current, and therefore the deflection of the needles of the galvanometers, is reversed.

The galvanometer coils are each wound to a resistance of 100 ohms, and a current of 15 to 20 milliamperes is required for satisfactory working.

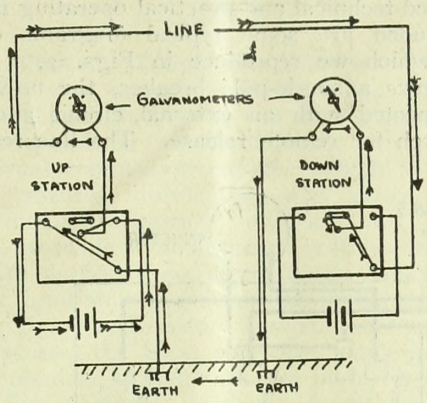


FIG. 5.

In single-current working, signalling is effected by stopping and starting the line current, a dot being distinguished from a dash by the duration of the current; spaces are intervals of no current on the line. Double-current working differs from single-current working in that a reverse current is sent to line during the intervals between the "marking" currents constituting a letter, so that there is always a current flowing along the line. With the single-needle system, although the signalling current flows in a different direction when signalling a dot than when signalling a dash, the spaces between the elements of a letter are intervals of no current; hence the method of working is actually single current. For instance, in signalling the letter H, which is four dots, the line signals in both the single-needle and single-current Morse systems would consist of four short-current impulses separated by intervals of no current; whereas in double-current working, the four marking-current impulses would be separated by spacing-current impulses flowing in the opposite direction along the line.

(To be continued.)

ELLISON "MILL" TYPE CIRCUIT BREAKERS.

This is a totally enclosed, "free" handle, magnetic blow-out, automatic circuit breaker for use in mills, factories, workshops and non-gaseous mines, to control and protect distribution circuits and motors. It is fitted with only one handle, which suffices for closing and for quick-break hand release.

The breaker parts are contained in a heavy cast-iron box with a cover over the front to give access to the interior, and a cover suspended from the underside to protect the trip adjustment and time-lag devices. The covers have packed joints, and, with the cable entrances properly closed, the whole is dust-tight and weatherproof; a stream of water may be directed upon it from a hose without risk of injury.

The current-carrying parts are mounted on steel rods covered with mechanically reinforced phenol-aldehyde insulation. Breakable materials such as slate or porcelain are not used.

The magnetic blow-out coils are series connected, and are fitted to both A.C. and D.C. breakers. The magnetic field is set up between cast-iron cheeks which are vitreous enamelled to serve as fireproof insulating barriers between the poles. The arc formed between the spark contacts is enclosed between the cheeks, and is controlled by the magnetic field throughout its length, thus ensuring the maximum breaking capacity.

The disposition of the contacts and the design of the magnetic system were determined on the results of exhaustive research, which gave data enabling the makers to state definitely the circuit-breaking capacity in amperes at various voltages. Thus, a No. 1 or No. 2 size breaker is listed to break 2,000 amperes on a 440-volt two-wire D.C. supply, and a No. 3 size breaker to break 4,000 amperes. The figures for A.C. are much higher. These values are for a non-inductive circuit, and it must be remembered that all practical D.C. and A.C. circuits are inductive; the effect under short-circuit conditions may be very considerable. A breaker on an inductive circuit acts as if it were breaking the steady line current at line volts plus the induced voltage rise. The induced voltage rise of a circuit may be calculated so that the correct size of breaker according to its breaking capacity can be selected for the job.

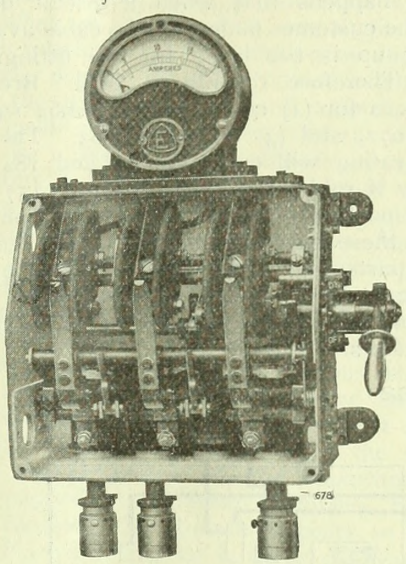


FIG. 1.

The breakers are made in single, double and triple-pole patterns with all the usual overload, no-voltage and other automatic features, adjustable time-lag devices and interlock arrangements.

The automatic tripping mechanism is very sensitive; the breaker is released with certainty on overloads and when the voltage fails suddenly or gradually. The no-volt plunger is actuated by a spring held in compression when the coil is energised. This spring is sufficiently strong to release the breaker even if the voltage falls off slowly, and the arrangement has the advantage that the plunger does not require raising by hand, as in some types of breakers, the tripping devices can be permanently enclosed as a protection against tampering, and it lends itself to electrical interlocking with motor starters or other gear.

The circuit breakers are made in three sizes, which are determined by the size of cable that can enter the

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cases and be connected to the terminals. This is a departure from the standard practice of rating breakers arbitrarily according to the current that they will carry at reasonable temperatures.

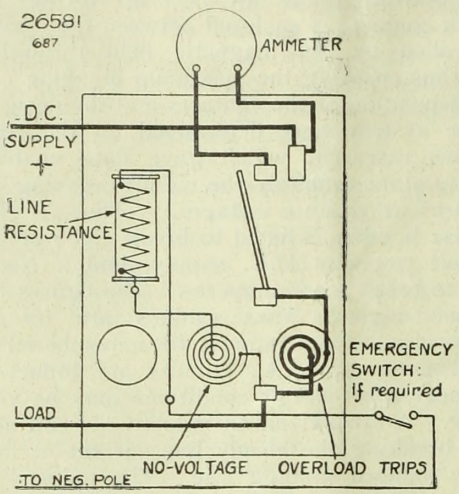


FIG. 2.

It often happens that when a circuit breaker is delivered the customer finds that the cable available for connecting up is too large for the fittings on the breakers. Therefore, the Ellison "Mill" Breakers are listed in sizes for (1) cables up to 7/.064 sq. in., (2) up to 19/.072, and (3) up to 37/.083. These cables at I.E.E. rating will carry 46, 97 and 184 amperes respectively if rubber insulated, and 75, 157 and 296 amperes respectively if paper insulated. The breakers will carry these currents without undue temperature rise of the parts, and if the user will run the cables at higher currents and consequent temperature rises, he must assume the same responsibility in regard to the circuit breakers.

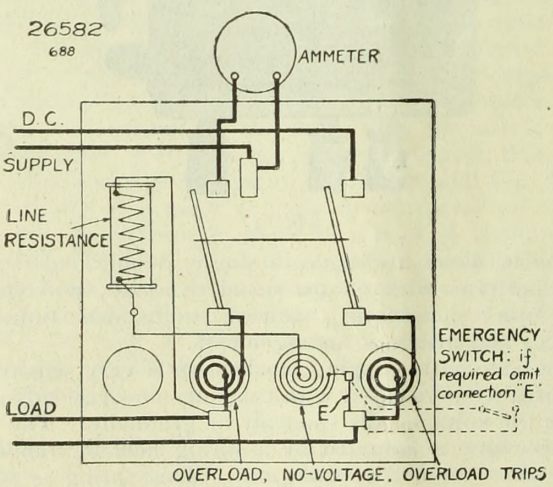


FIG. 3.

Cable entrances to the breaker box are provided at either side, and cone clamps, sealing or dividing boxes are supplied by the makers for any class of cable.

Ammeters can be mounted on the breakers if required, and the breakers may be supplied with lugs for bolting to walls or with stands for erection on floors.

The general construction may be seen by reference to Fig 1, and, in conclusion, it should be mentioned that the makers, George Ellison (Perry Bar, Birmingham), have recently issued a new list, No. 17, which, in keeping with their usual valuable practice, is replete with detailed technical and practical operating information. Included are some typical diagrams of connections, which we reproduce in Figs. 2, 3 and 4. Fig. 2 shows a single-pole breaker, the no-volt coil being connected with an external circuit and emergency switch for remote release. The line resistance

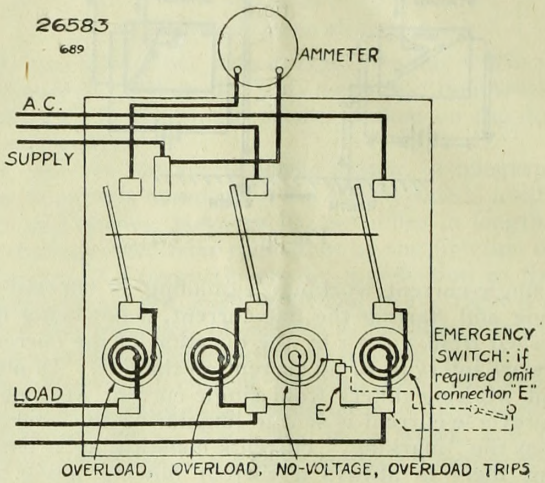


FIG. 4.

is necessary for D.C. circuits over 120 volts, but not for A.C. Fig. 3 illustrates a double-pole breaker. The no-volt coil is connected between poles on the load side of the breaker, and a link is inserted in the coil circuit to provide terminals for connections to an emergency switch, if required. Here, again, the line resistance is only necessary for D.C. over 120 volts. Fig. 4 shows a triple-pole breaker, and is the standard arrangement for three-phase systems with earthed neutrals. These connections are for the breakers (No. 1 size) illustrated in Fig. 1.

Various Items.

Wages.—A printed slip (No. 1) has been issued by the National Federated Electrical Association showing the rates of wages now in force in the different parts of England under the agreement with the Electrical Trades Union.

Local Electrical Exhibitions.—Arrangements are being made for a local exhibition in Walsall, November 5 to 10. Considerable space will be allocated to the gas and electricity undertakings, and the exhibition will be advertised in the usual way.

French Radio Enthusiasts Demoralise Wire Service.—"Listeners-in" who daily hear the concerts broadcast by the Eiffel Tower wireless are accused of adding to the already great confusion and disorganisation of the telephone and telegraph service of France. Officials of the telegraph administration assert as an excuse for the irregular service that wires are being grounded everywhere by amateur wireless enthusiasts who do not know better than to connect their listening apparatus to telegraph and telephone wires. The result, the officials state, is grounding and endless trouble for the telegraph administration. There is talk of issuing an order requiring everybody to apply to the administration for permission to install a wireless outfit in order to keep the official wires free.

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Reviews of Books, &c.

[Books noticed in this column will be sent from ELECTRICITY *Office to any part of the world, for the published price, plus five per cent. for postage (minimum 2d.), and orders will be appreciated.]*

SPARKING PLUGS. Young and Warren. (Pitman. 2s. 6d.)—The vital importance of Sparking Plug design evidenced itself during the war in connection with the ignition problems associated with aircraft and special internal combustion engines, which in speed, explosion pressures, lubrication and other details marked a distinct departure from anything accomplished prior to 1914. The authors are fully competent to write with authority on this subject, having been engaged on ignition research in the Laboratories of the British Thomson-Houston Company for upwards of six years, and the book embodies much practical information obtained in the source of these researches. There are five chapters dealing, respectively, with Electric Ignition, Sparking Plug Design, Sparking Electrodes, Composition and Properties of Plug Insulation, and descriptions of some of the leading makes. The illustrations throughout are clear, and for the benefit of those who desire to delve more deeply into the subject there is a convenient bibliography of existing literature bearing on sparking plugs and ignition in internal combustion engines. The primer should prove of service and interest generally to motorists and those concerned with aviation.

SIMPLE VALVE RECEIVING SETS AND HOW TO MAKE THEM. Edited By Bernard E. Jones. (Cassell. 1s. 6d. net.)—This is another handbook of the "Amateur Wireless" series, and is compiled from the writings of many contributors to the pages of "Amateur Wireless."

It contains much valuable information, and is written clearly and concisely. The illustrations are good, and the diagrams particularly to be recommended. The articles cover practically all the types of receiving sets and amplifiers adopted for general broadcast receiving, and the more advanced amateur who wishes to construct apparatus slightly in advance of the usual amateur receiving gear would do well to consult the details given for an amateur wireless unit set.

In one of the early pages in the book the high-tension battery is dealt with, and the suggestion made that "discarded electric bell dry cells may be used." Where in one or two cases such a battery may be successful, in the majority of cases it will definitely be unsuccessful, and from a battery point of view we should not dream of advising anyone to adopt any type of discarded cell for use as the high-tension supply to wireless receiving apparatus. For quiet and efficient working a really good high-tension battery is an essential.

We strongly recommend the book to amateurs interested in building their own sets.

PRESS-THE-BUTTON TELEGRAPHY. By Donald Murray, M.I.E.E. 2nd edn. (Rentell, 2s. net).—We are very pleased indeed to receive from Mr. Murray a copy of the reprint of his series of articles which appeared in the *Telegraph and Telephone Journal* from November, 1914, to July, 1915, more particularly in view of the fact that it has been revised and brought up to date to May 25, 1923. It is a well-illustrated work of 84 pages, and is certain to interest a very large number of the readers of this paper who are in any way associated with telegraph work, either in Government or railway service, in this country or in the Colonies. We are, therefore, pleased to think that Mr. Murray has decided to issue this second edition, as it is certain to meet with hearty appreciation.

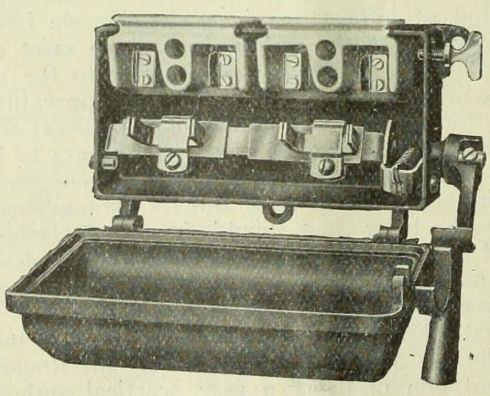
COMMENT RECEVOIR LA TELEPHONIE SANS FIL. By Joseph Roussel. (Librairie Vuibert, Paris. Price 5s. net.)—So many books have been, and are being, written on matters pertaining to wireless telephony, and as all these books must obviously cover the same ground, it at times becomes difficult to express an opinion on the value of the work, and to endeavour to differentiate between one book and the next, with a view to giving persons interested in wireless some idea of the scope of such books. This book of M. Roussel's is of very great interest, giving as it does a large amount of valuable information to the French amateur. To anyone interested in the subject, and having only a smattering of French, the book is still very strongly to be recommended, and although it covers the same ground as so many other books, it does deal with the subject from what we might call a new angle. Even to the English amateur, the information on the Eiffel Tower Station, details of their transmissions and definitions of the terms used, will all appeal, as the Station is so easily received in this country. Following his data is a collection of records of amateur receiving stations in Paris, and other places at varying distances from Paris up to 702 kilometres. These details are arranged in order of distance from the Eiffel Tower Station. Particulars are given of the apparatus at these various stations, and notes upon the results obtained when listening to Eiffel Towel transmissions. Following this list is a series of notes relating to the particulars of the various stations. This kind of information is something we have not previously met with, and it appears to meet a very long felt want. So many people new to the subject are enquiring for particulars of the apparatus they require for reception at different distances from a Broadcasting Station. M. Roussel appears to be the first to fulfil this want, and he is to be congratulated upon the collection of data and its arrangement. In reading the book one should, however, always bear in mind that the transmissions particularly referred to are on the 2,600 metre wave length, and not on the low wave lengths in operation in this country. Further, that other data such as described aerials may not be of the size and type allowed here. M. Roussel has the reputation of being a very practical author, and this reputation is upheld throughout the book. The construction of various sets is described and values and winding data given. To the more advanced amateur, the portion of the book dealing with transmissions will will repay study, and a large amount of practical information will be obtained. After having read through the book, one cannot help noticing how well the ground has been covered, and we can most strongly recommend it to all persons interested in the subject who have even only a small knowledge of the French language. An English translation would undoubtedly have a ready sale in this country.

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CALCULATIONS IN HEATING AND VENTILATION. By G. S. Coleman, D.Sc., A.M.I.C.E. (Longmans, 15s. net.)—The author is to be congratulated on the production of a book which will be appreciated by engineers and students alike. Engineers will appreciate it because it will be a very handy book of reference to have upon the shelves when in doubt. The student will find it not only useful, but extremely cheap, and this is a consideration these days. The chief brake on the progress a student wishes to make is the high price of books. He finds that, as a rule, if he wishes to study for an examination he has to purchase several books, since the subjects in the syllabus of his school or college are so varied. In the book we are considering several subjects are adequately dealt with, thus virtually embodying several books in one. Work, power, energy, friction, heat, steam, air, fans, boilers and fuels are but a few of the subjects treated on. The chapters devoted to the flow of air in ducts and fans, and their capacity, should be of interest to municipal and construction engineers who wish to know all about this important subject. Ventilation in the turbo-alternator is of supreme importance, yet it is astonishing how very little the subject is understood. We predict a good sale for this excellent work.

SOMETHING NEW IN SWITCH GEAR.

The Midland Electric Manufacturing Company, Ltd. (Barford Street, Birmingham), have just introduced a new range of Ironclad switch gear under the trade name "Memak." The new switches are of the Quick-Make type, but are lighter in character than previous designs, so that, in addition to their use on industrial installations, they are particularly suitable for house service work, and for heating and cooking apparatus where a "fool-proof" switch of neat appearance is a real necessity.



The advantages of quick-make switches in domestic installations can hardly be overstated. Once a lady or domestic servant has seen a switch burnt out through faulty switching-in, their faith in the safety of electrical apparatus is rudely shaken. In the "Memak" switch, perfect contact is assured with a very light touch; the break is equally easy and rapid.

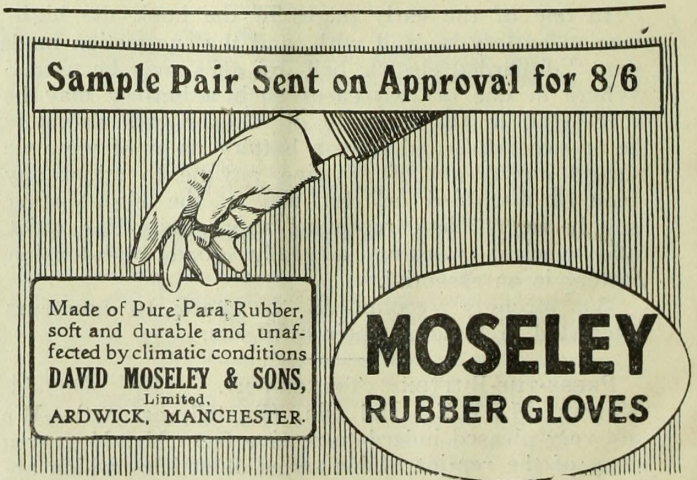
Owing to the simplicity of design and the well-known M.E.M. standardised methods of production, the prices of these switches, considering their general excellence, are extremely keen.

The illustration shows a 500-volt D.P. "Memak" Ironclad switch, fuller particulars of which and of similar switches mounted with patent "Kantark" fuses, are given in a new list, No. 137, to be obtained from the M.E.M. Company.

Trade Notes.

A new device for electrically recording water levels and other similar functions where the recording station is situated at a distance from the site has just been placed on the market by the **Telechron Electric Transmitter Co.**, 53, Victoria Street, S.W. The apparatus, which differs in principle from all previous apparatus designed for this purpose, comprises two main parts—(1) the transmitter, (2) the indicator. The former comprises a cast-iron case with watertight cover and glands, enclosing the mechanism, the only external portion being a rotating boss or pulley for actuation by a rising and falling float or other conventional means. A differential gear connected with this external driving source is so arranged that any rotary motion of the pulley in either direction actuates a release mechanism closing one or other of two switches. Each switch controls the circuit of an electromagnet, which in turn operates a switch-resetting mechanism whenever current flows from the battery, through the indicator, and along the line to the transmitter. Thus there is no current flow until there is a definite movement of the pulley. Should the current fail, the transmitter switch remains in contact, whilst if the direction of rotation is reversed the other switch will close circuit and remain closed until current is re-established, when the transmitter automatically sends correcting impulses along the line to restore the indicator to synchronism. The indicator is of similar robust construction, and embodies a differential gear operated by two electro-magnets. The indications are given on an eight-inch dial by means of one or two pointers, according to requirements. When a current impulse is received from the transmitter, one or other of the electro-magnets is energised and the hands are driven either clockwise or counter-clockwise, according to the direction of rotation of the transmitter pulley, representing a rise or fall in the level to be indicated. The movement is step by step, and absolute synchronism is assured. The installation is the simplest possible, two line wires and an earth connection at either station sufficing. In addition to water-level indication, the telechron has numerous other applications—e.g., position of mine cages, pressure in gas mains, helm indicators, order telegraphs, etc.

Plant Wanted.—The State Electricity Works at Montevideo invite tenders for low-tension armoured cables, telephone cables and accessories.——The Municipal Council of Johannesburg invite tenders for a rotary converter.——The Municipality of Toronto, in Canada, invite tenders for an alternating current generator.——The Municipal Council at Sydney invite tenders for the supply of high-tension switchgear and apparatus.——Full details of all the above opportunities for British trade may be obtained from the D.O.T. (Room 52), 35, Old Queen Street, London, S.W.1.



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A POPULAR SCIENTIFIC WEEKLY JOURNAL
ELECTRICITY
A PRACTICAL TRADE JOURNAL

AUGUST 31, 1923.

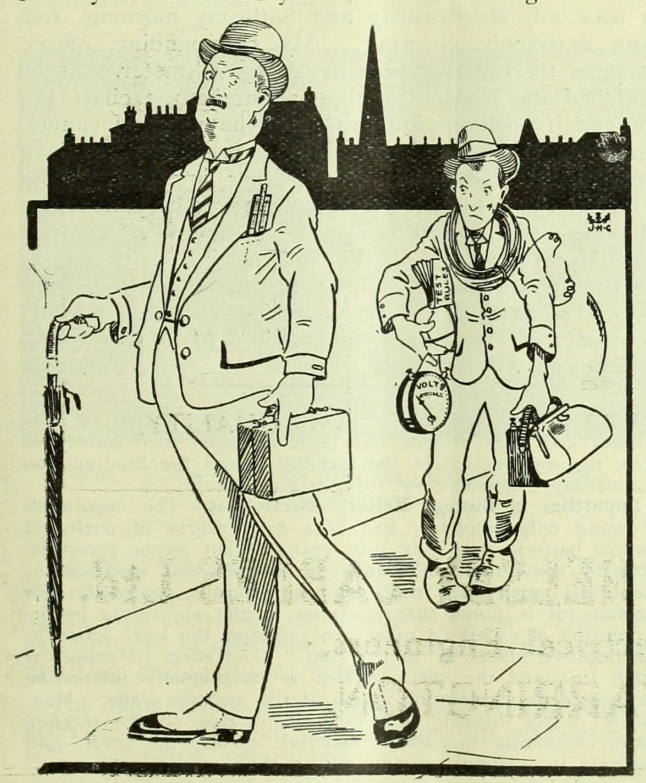
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A METER TESTER AND HIS 'PRENTICE.

By George E. Moore.

Those of you who live "round our way" must often have seen me in the days of long ago. It was my fate to be the right-hand man (*and* the left-hand man—in fact, general factotum) to an imposing individual whose job was testing power meters on site. Perhaps you will remember all the more readily if I describe our appearance as we made our way on foot to a scene of action. Striding ahead with an attaché case of business-like appearance (containing lunch) would be my boss; his brow would be wrinkled in thought, for he always tried to be loyal to both alternating currents



and the latest "dead cert." Staggering along behind him came a youth carrying the odds and ends for the test. That youth was me.

Before we started out to investigate faults or test meters I was always on tenterhooks, though to tell you the truth I was *never* really easy in my mind when with my boss. Even when his back was turned towards me I still felt his eagle eye on me. You'll know the feeling. I was supposed, with the help of experience and instinct (and a good deal of thought-reading, too), to know what was required in the way of instruments, and so forth. (I was never right, of course. There was always something left out. But I had some close shaves.) Before we actually left headquarters I would be put through a sort of cross-examination. Let's see now—had I got our lunches? Good! And our coats? Right! Well, then, there was the slide-rule, book of Test House laws, check-meter, voltmeter and wires. Then there's the bag of tools—naturally *that* has been forgotten.

The lunch item was very important. I might possibly forget mine—or perhaps I hadn't been warned. Not so my boss. He was never caught napping. Once we set out on an all-day job, I not having come prepared for this. When 12 o'clock came we were in a works and surrounded by pieces of a dissembled polyphase meter. The works hooter sounded and my superior promptly put down his dissecting tools and hauled out a packet of meat sandwiches. I gazed gloomily through the window at the works employees *en route* to dinner. I seemed to have an extraordinary appetite that day.

"Hello!" said my chief, with a look of surprise. "Haven't *you* got any lunch?" "No," I replied sulkily—for his question was quite unnecessary. "Oh!" he said, and a thoughtful look settled on his face as he waded through the next sandwich. I looked at his face with a certain amount of anxiety. The sandwiches seemed to be disappearing at remarkable speed. "That's a pity," he observed at last, "for *I've* only enough for meself." I muttered something. "I'll tell you what," he said in a hopeful sort of voice. "You can clean-up that meter dial." I found the meter dial very unappetising. As a reward I was presented with a whole banana. It was a bit decomposed, but only as regards part of its innards. I did feel bucked up, you know, after that.

On another occasion we had been to a job which had proved so formidable that we had tackled our lunches at 11 o'clock. By 2 o'clock we were walking to have a look at a meter which had decided to break one of the immutable commandments of metering—it had been reported "going backwards!" Whilst passing a café my chief called a halt. "Now, Moorie," he said, "we're both peckish. What do you want to do—work right on and knock-off early, or have a snack here?" "Work right on," I replied. "Moorie," he said, "you're a young fool. *You* go on. *I'm* turning in here." And sure enough he did! Needless to say, I followed suit. I could do nothing else, for he was the sort of leader who believed in keeping his army "in the dark" about the plans.

As an experimentalist he was second to none, and would have been a good man on cable research and stuff like that. For instance, if he suspected a wire of being alive he would depute the job, or at least the holding of the suspected wire, to me. If I yelped it was evident that there was an unpleasantly high

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potential. He would then keep clear until the job was finished, or else I would be retired and he would "carry on" with special wariness once the wire had shown what it could do. When he *knew* everything was "dead" I would be definitely cold-shouldered, and he would proceed with astonishing confidence. However, so-called "dead" things may have quite a lot of life in them—so I sometimes got my revenge!

I don't want you to think, though, that he always made a practice of grabbing the important parts of jobs and making me always a mere supernumerary. Not at all! I remember one occasion when, much to my surprise, we avoided the entrance of a works which we had to visit and went by a most unpleasant and muddy path round to the back, and there stopped by a high hoarding covered with nasty-looking spikes.

"Now then," he said, "I've decided it's time you had a chance to show what you can do. I've had a bit of a row with one of the bosses inside there, but we've got to get into our Company's 'sub' and put in the check-meter you've been humping along. So I want you to hop over and connect it in."

Well, after a great deal of scrambling and cussing (especially from my boss when my boot went into his mouth), I and the meter arrived on the other side of the hoarding. The coast was clear, though you wouldn't have thought so if you'd heard my first technical report through the hoarding. I took my time in the sub-station, naturally. I revelled in the unwonted freedom and responsibility! Once, when a furnace in the works was opened and made a fearful din, I heard an agonised question from my chief. I took not the slightest notice. By the time I appeared again on top of the hoarding his agony of mind was pitiful. However, he was alert enough to keep a watchful eye on my boots as I scrambled down.

On that occasion, as you have seen, I carried through the whole job—even unto locking the sub-station door. Now locking the door was, in my boss's eye, of great importance. Of course electrical gear must be safe-guarded, but I was staggered in those days by the weighty manner in which the law was laid down to me.

The first time I was out with my chief he had told me to lock-up. As we walked away he suddenly said:

"Moorie, have you locked that door?"

"Yes," I replied, "I think so."

"There's no thinking about it," he said. "Either you locked the door or you didn't. Where does the thinking come in? Did you hear it click?"

"No," I said, "can't say I did."

"Did you shake it?"

"No!"

"Well, I'm jiggered. You come here, and you get jolly good pay (better pay than I ever had) and a good boss, and yet you can't be trusted to lock a blinking door. By gosh! Why, you'd be had up for man-slaughter—I shouldn't be surprised at murder—if somebody walked in and got electrocuted through you. And can't you see—*while you're locking that blooming door I'm planning out the next place!*"

Needless to say, that squashed me. On another occasion, in a traction sub-station, I went through a similar merciless "telling off." An old commutator-type of D.C. meter had been giving a lot of trouble. Well, everything was tried without success. My leader turned to me at last and said:

"Now, Moorie, you've seen what I've done. I've cleaned the gearing, touched up the pivots, blown through the magnet gaps and adjusted the friction compensator, and still she won't quicken up on low load. Now you reckon you're a smart chap, what with a college education and all that. *Why won't that meter buck up?*"

I adopted a judicial air. "Well," I said, "let's see now. You've cleaned the gearing?"

"Yes."

"And touched up the pivots?"

"Of course."

"And blown through the mags?"

"Didn't you see me?"

"And adjusted the compensator?"

"Aye!"

"Well, then," I said, "I'm blowed if *I* know why it won't go."

For some reason my boss lost his temper at this juncture. When he recovered I treated him to tea at a near-by café, and on the return we repaired a hinge on the meter case and then went home. Next day when we called the meter was O.K. It was all very puzzling. Perhaps the warming up was responsible. Surely it couldn't be the hinge! Between you and me, my opinion is that the meter was all right when we weren't bothering it. A fellow in a test-house once told me meters are almost human, they are so *mulish*. But most meters tend to go quicker when they warm up. *That* doesn't seem human, does it?

I suppose you'll have got the idea that that boss of mine was rather a "hard case." By no means. Believe me, he had his tender moods. I will recount an incident which quite staggered me, for it revealed his poetical temperament. (Fancy one's poetical temperament surviving meter-testing!) One day we had finished quite a successful job. This, and the fact that it was only eleven-thirty and Saturday morning, too, was extremely cheering. My commanding officer stopped to contemplate a recording voltmeter. As he watched the pointer joggling about on the chart I'm hanged if he didn't quote Omar Khayyám. I cannot do better than give you his version—the verse is a very fitting conclusion to a rather impertinent biography. I'm sorry I can't include all the philosophic shakings of the head.

The Moving Finger writes; and having writ,
Moves on, Moorie: nor all thy Piety nor Wit
Shall lure it back to cancel half a Line,
Nor all thy Tears wash out a Word of it, you young beggar!

B.E.X., 1924.—A visit of members of the Society of Engineers and their friends has been arranged to Wembley to view the construction of the Exhibition and the Stadium, on Wednesday, September 19, 1923, at 2.30 p.m.

Impurities in Storage Battery Electrolytes.—The importance of using only sulphuric acid of a high degree of purity in storage batteries has long been realised, but recent investigations by the Bureau of Standards indicate that specifications should be much more rigid than is generally supposed. For instance, it is found that platinum in the electrolyte in the proportion of 1 part in 10,000,000 increases the local action at the negative plates by 50 per cent.! The effect of copper is much less, and the effect of iron is exceptionally interesting because of its accelerating action at the negative plates. Manganese causes deposits of manganese dioxide on the positive plates, screening the active material, closing the pores, and resulting in wasteful gassing during the charge.

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THE EDISWAN WORKS VISITED.

VALVES AND SETS FOR WIRELESS INSPECTED.

The name "Ediswan" being one held in esteem by the community, electrical and lay, owing to the fact that it is associated with some of the early pioneer work, as well as more recent electrical developments, it was with pleasure that we accepted a recent invitation from the Edison Swan Electric Co., Ltd., to visit their extensive works at Ponder's End, Middlesex. These

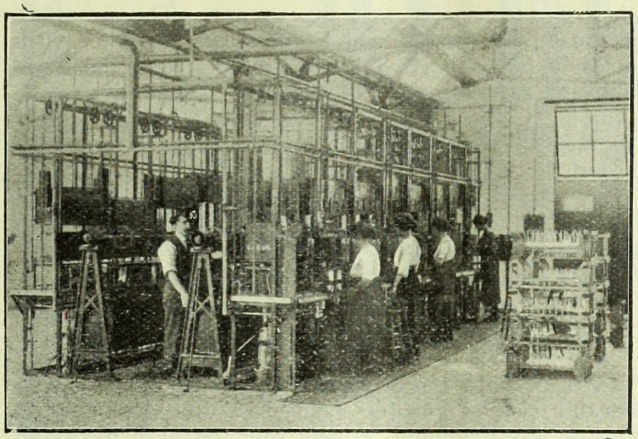


FIG. 1.—SOME OF THE VALVE EXHAUSTING BENCHES.

works cover an area of approximately 36 acres and give employment to several thousand hands, the products being of a varied nature and familiar to trade readers. Particular attention, therefore, was devoted to an inspection of some special lines of manufacture, including valves, wireless components and sets, accumulators and dry cells.

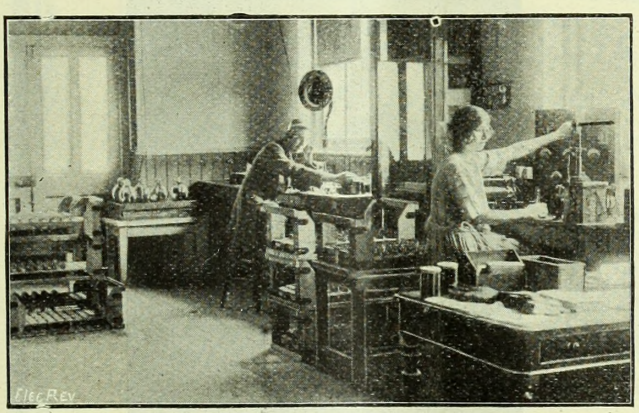


FIG. 2.—A CORNER OF THE VALVE TESTING DEPARTMENT.

The first department visited was the glass houses, where the manufacture of bulbs of all types, both for valves and electric lamps, was in progress. There are five furnaces in operation, and work is carried on continuously during the 24 hours.

The manufacture of glass tubing is a very interesting process, the skill and accuracy of the operatives in this work being remarkable.

The next place visited was the new valve shop, a spacious building specially built to deal with the manufacture of Ediswan valves of all types. The floor space is approximately 14,000 square feet, and many interesting operations were in progress. A very neat little machine for fixing grids to their supports was particularly interesting, as also were the welding machines for fixing plates to their supporting stems. It may be of interest to note that there are some sixteen different chemical elements used in the manufacture of a valve and about twenty-three separate operations.

A valve of considerable interest is the new Ediswan dull emitter type, A.R.D.E. It has given splendid results on test and in actual practice. The filament is considerably stronger than that of an ordinary type valve, and it has a longer life in consequence of the low temperature at which it is run (somewhere about 40 deg. below that of an ordinary A.R. type).

The valve test room is another spacious, well-laid-out department. Here every valve is subjected to the most rigid test, and a certain number from each batch is also tested on actual receiving work. It might be mentioned here that in addition to the large valve shop and this test room, about 4,000 square feet of space in another part of the factory is also devoted to valve work.



FIG. 3.—ACCUMULATOR ASSEMBLY SHOP.

The engineering side of the works was next visited, the first department being the dry cell shop, where high-tension batteries of all types were being manufactured.

Next the accumulator shop was inspected, and every process from the casting of the grids, the sawing off, pasting, forming, to the final assembling, was inspected.

A visit was then paid to the wireless shop, where crystal and valve sets in all stages of manufacture were examined. The manufacture of components of all types, such as high and low frequency transformers, variable condensers, Dewar type keys, is also carried out in its entirety.

Another interesting feature was the manufacture of the Ediswan headphones. These instruments, which are made throughout in the works, possess some novel features and are very comfortable to use.

[We are indebted to the *Electrical Review* for the blocks used to illustrate this article.]

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A COLLIERY AT WEMBLEY.

From a Correspondent.

A full-sized colliery, complete with headgear, pit ponies, underground stables, washeries and all the most up-to-date paraphernalia of coal mining, seen in actual operation, is to be one of the many sensations of the British Empire Exhibition at Wembley next year.

Coal mining, the mainspring of our national wealth and our premier industry, requires to be represented in some special manner consistent with its importance, and the sinking and construction of a working colliery has been the final decision. The idea originated in the Mining Association of Great Britain, the coal-owners' organisation, which granted the money necessary for the purpose. The cost of plant and construction was estimated at £100,000, but the sum was readily voted. It was felt that so comprehensive an undertaking as the British Empire Exhibition would not be complete without some idea being given of the problems with which the coal mining industry has to deal, and of the enormous progress that has been made in technique since the early days.

The Mining Association invited the co-operation of the Institution of Mining Engineers and of the Miners' Federation of Great Britain in working out the scheme. A joint committee of representatives of the three bodies has been engaged on this work for some time, and plans are now prepared for the commencement of the operations of sinking the shafts, excavating the underground galleries, and installing the elaborate and costly surface plant which is an essential part of the equipment of every colliery.

One of the principal features of the mine will be an electric winding engine, which will be able to lower into the workings 2,000 people an hour. Over the top of the shaft, which will be 18 ft. in diameter, will be erected a steel headgear 80 ft. high. The headgear will be equipped with pulleys 15 ft. in diameter, and will be of lattice work construction.

Next to the winding engine house will be a lamp-room containing electric and oil lamps. Adjacent to this will be offices, bathrooms for miners, a motor-ambulance house, workshops and electrically driven air compressors. An electrically driven fan will be seen in operation, ventilating the labyrinth of underground tunnels that extend about a quarter of a mile.

After inspecting the surface plant, visitors will be lowered in a two-decked cage to the shaft bottom, and will step out into actual underground workings. The cage by which the public will be taken underground will be an actual reproduction of a colliery cage which lowers and raises the miners daily, and hoists coal to the surface.

The first machinery that will catch the eye underground will be an electrically driven pump, busily at work pumping water. Different methods of supporting the ground overhead will be shown, including the use of steel as a main support. Next will be seen a haulage-engine which hauls the coal from the workings, which in many collieries are over a mile away from the bottom of the shaft. The public will see the pit ponies in their underground stables where their lives are spent. The manner in which they are cared for will be explained.

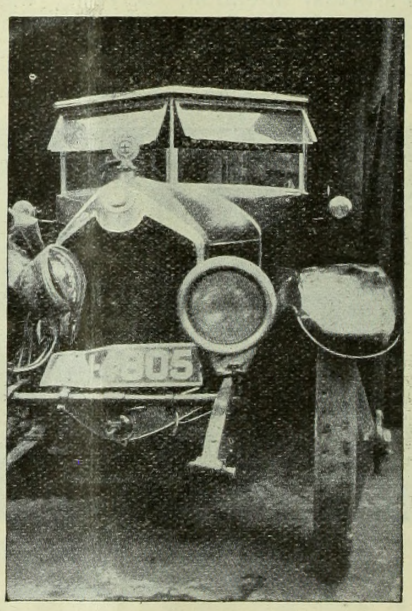
Penetrating farther into the mine, the explorers will observe the various methods of getting coal, first by colliers with the pick, and secondly by electrical and compressed air mechanical cutters. Mechanical conveyors will be seen moving the coal to pit trams, in which it is hauled to the bottom of the shaft, ready for hoisting. Another interesting underground department will be a fully equipped ambulance-room, where first aid is rendered in case of accident.

After leaving the workings, visitors, having regained the surface, will pass into a large hall, where they will see the progress that has been made in the mining industry during the past fifty years. The primitive tools used by miners will be on view, together with the early lamps carried by the miners, and the more elaborate safety lamps of to-day. The visit to the Wembley Colliery will conclude with a cinema entertainment showing miners actually at work underground.

The purpose of the exhibit is to give the general public a glimpse into the highly technical and complicated business of coal-mining. It should prove one of the strongest attractions of the whole Exhibition.

WITH EYES UNDIMMED.

Users of road motor vehicles nowadays run a considerable risk of getting themselves and their mounts more or less damaged, at any rate, on high days and holidays. Considerable satisfaction may, however, be derived from the knowledge that the art of electric lamp manufacture has arrived at such a high standard that there is a good chance of the lamp surviving intact. Instances frequently come to our notice, and for the latest we are indebted to the G.E.C., who,

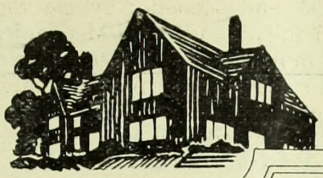


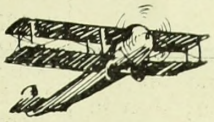
in sending an illustration of a Crossley car which has evidently suffered considerable damage to one of the headlamps, state :—

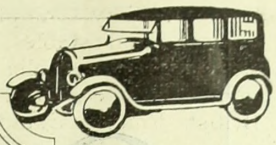
"Our customers, Messrs. Mortimore and Hall, motor and electrical engineers, The Beach Hotel Garage, Littlehampton, inform us that after the accident the Osram gasfilled bulb fitted to this headlamp was still in perfect condition and ready for further service."

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START OUR AEROPLANES





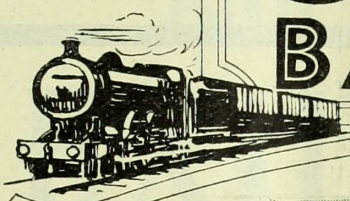


LIGHT OUR HOMES

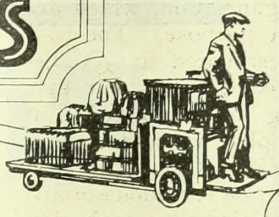
START OUR MOTOR CARS

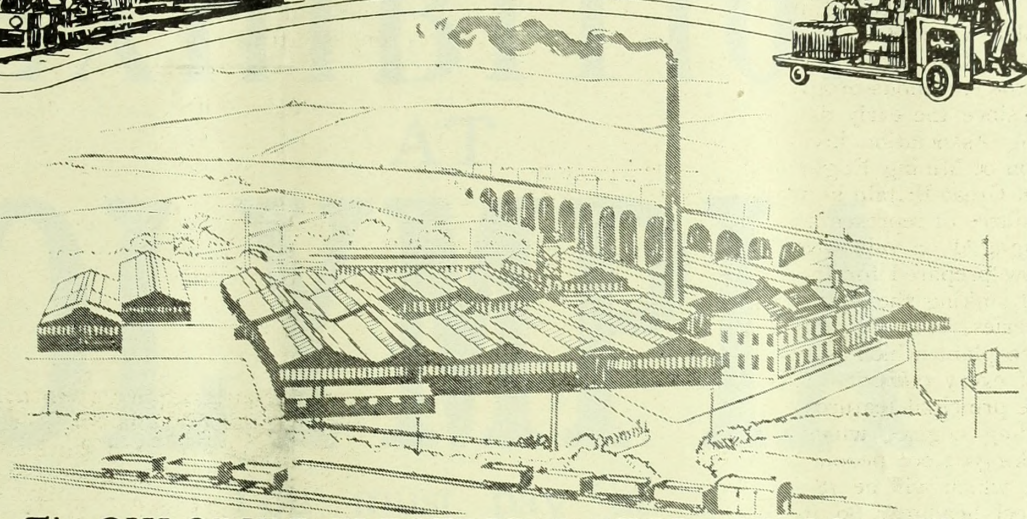
Chloride BATTERIES

LIGHT OUR TRAINS



DRIVE OUR TRUCKS

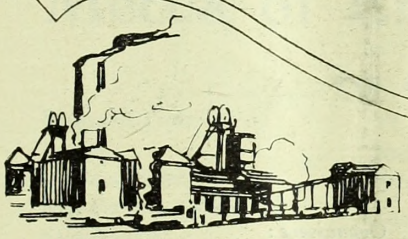




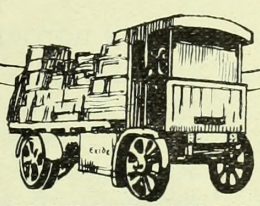
The CHLORIDE ELECTRICAL STORAGE CO., LTD.

Clifton Junction, Nr. MANCHESTER

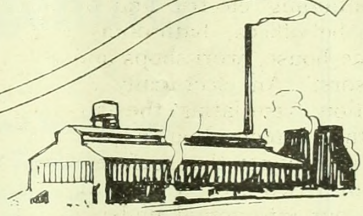
and at BOMBAY, CALCUTTA, SYDNEY, JOHANNESBURG, Etc.



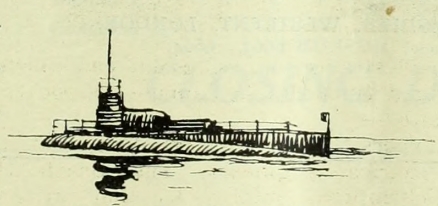
LIGHT OUR COAL MINES



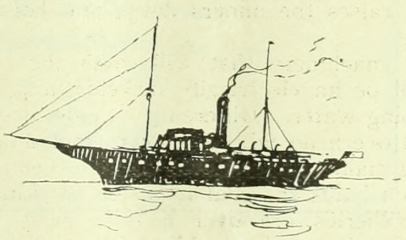
WORK OUR LORRIES



RUN OUR POWER STATIONS



DRIVE OUR SUBMARINES



LIGHT OUR PLEASURE YACHTS

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THE GREAT

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EXHIBITION

AT

OLYMPIA

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Mecca of Engineering Ingenuity

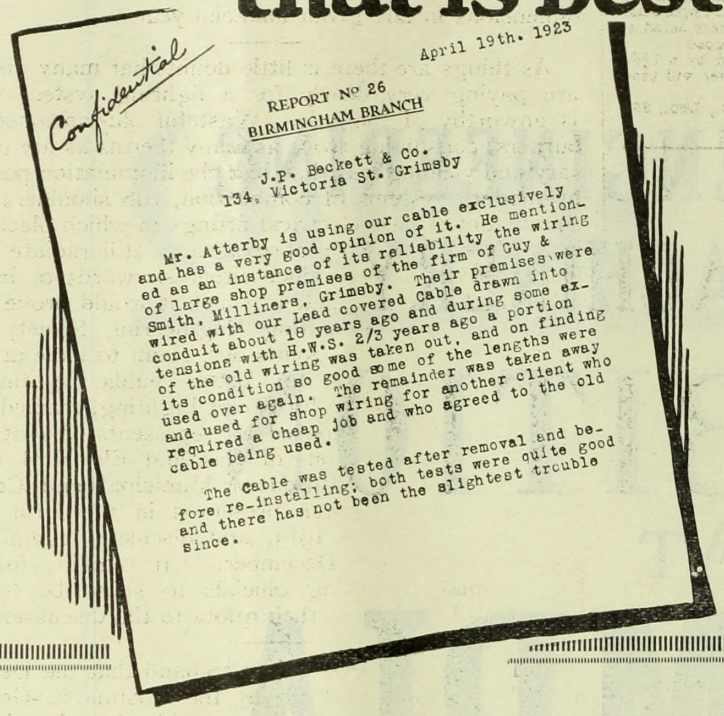
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Searchlights,
Sirens,
Winches,
Turbines,
Condensers,
Ventilating Machinery,
Heating Apparatus,
Steam Engines,
Loading, Discharging, Conveying, &c., Equipments,
Motor Boats,
Marine and Stationary Internal Combustion Engines,
Yachts and Small Craft,
Wireless Telegraphy,
Oxy-Acetylene and Electric Welding,
Life-Saving Equipment,
Boat-Lowering Devices,
Electrical Specialities,
&c. &c.

CLOSING DATE, SEPT. 22nd.

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A Confidential Report that is best made public-


Confidential

April 19th. 1923

REPORT No 26
BIRMINGHAM BRANCH

J.P. Beckett & Co.
134, Victoria St. Grimsby

Mr. Atterby is using our cable exclusively and has a very good opinion of it. He mentioned as an instance of its reliability the wiring of large shop premises of the firm of Guy & Smith, Milliners, Grimsby. Their premises were wired with our Lead covered Cable drawn into conduit about 18 years ago and during some extensions with H.W.S. 2/3 years ago a portion of the old wiring was taken out, and on finding its condition so good some of the lengths were used over again. The remainder was taken away and used for shop wiring for another client who required a cheap job and who agreed to the old cable being used.

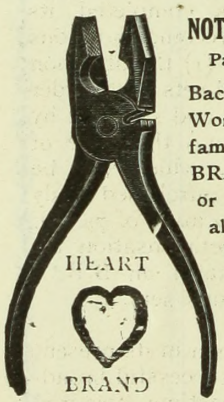
The Cable was tested after removal and before re-installing; both tests were quite good and there has not been the slightest trouble since.

Another Henley Cable that is working overtime

HENLEY
CABLES & WIRES

W. T. HENLEY'S TELEGRAPH WORKS Co., Ltd.,
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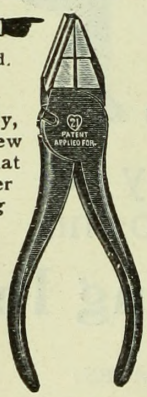


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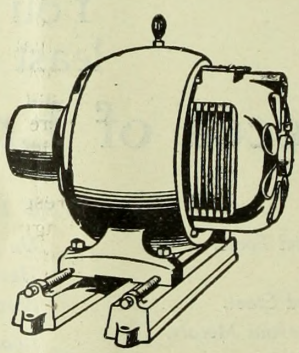
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TO OUR READERS.

ELECTRICITY is published every Friday, and, if ordered, is on sale at the principal Railway Station Bookstalls and Newsagents on that day. It has a very large sale throughout the United Kingdom, as well as in the British Colonies and Abroad.

New advertisements for the displayed columns and alterations to existing ones must reach the publishing office not later than first post Tuesday morning, in order to be in time for the issue of the following Friday. This is important. Rate quoted on application. Subscription: 13s. a year, 6s. 6d. half year, 3s. 3d. a quarter in advance, postage prepaid in the United Kingdom and abroad.

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Current Topics.

Public Lighting.

The lighting of public thoroughfares which was indifferently carried out in the majority of British towns before 1914 and fell into desuetude during the war years, has never really yet been properly handled on a uniform basis making for maximum efficiency and a common standard of illumination in terms of area for all populous centres and classes of streets and roads. Visiting various towns and suburban districts and making a cursory study of the public lighting, one cannot fail to be struck by the enormous variety of fixtures employed, their spacing, general arrangement, types of lantern, height, relative cleanliness, etc. Such a survey immediately impresses the observer with the neglect to which this important public service is subject, and further emphasises the need, already instanced by correspondence in the columns of my esteemed contemporary, *Municipal Engineering*, for reform.

In a recent issue of that journal a correspondent, himself a Borough Surveyor, suggested the formation of an Institute of Public Lighting Superintendents and Engineers, a proposal which has since been well supported by further correspondents. There would certainly appear room for some concentration of professional effort upon this much needed reform, but such a body already exists in the Illuminating Engineering Society, and if that Society has not hitherto evinced a very active interest in the important subject of public lighting it is obviously because there is a lack of support from the men who are responsible for the illumination of our cities and towns. Let all the principal lighting superintendents and engineers responsible for public lighting join the Illuminating Engineering Society, attend its meetings, and learn more about the wonderful developments which have come about of recent years in the science of illumination.

By contributing their quota of practical experience of the problems to be solved in evolving a satisfactory general scheme of street lighting, such a combination of intellects would speedily bring about much needed improvements in this direction without necessarily involving their respective ratepayers in immediate or overwhelming expenditure. As things are at present, any existing scheme of lighting, however antiquated or inefficient, is regarded as good enough, and the average responsible officer only concerns himself with the lighting and extinguishing of the lamps at sunset and sunrise or earlier according to local practice, a duty which could obviously be relegated to any intelligent lamplighter. Many existing standards could be modernised and made to support far more efficient illuminating units with a little forethought, whilst, in extreme cases, a well-considered scheme of total conversion need not necessarily be indefinitely shelved on the score of expense, but, if judiciously planned, could be spread over a sufficient term to limit the expenditure to reasonable dimensions in any given financial year.

As things are there is little doubt that many districts are paying very dearly for a lighting system which is unworthy of the title. Wasteful old-fashioned gas burners, consuming twice as many therms as are necessary and yielding less than half the illumination possible by modern systems of combustion, rub shoulders with equally out of date electrical fittings in which blackened incandescent bulbs, or obsolete arcs still radiate what little light they do produce either skywards or in any other direction save that in which it would prove most useful. The Illuminating Engineering Society can, as its Hon. Secretary points out, claim to have at least initiated a campaign for better public lighting, a Standard Specification for Street Lighting, framed by a joint Committee composed of representatives of that Society, the Institutions of Gas and Electrical Engineers, and the Institution of Municipal and County Engineers, having been presented in the form of a paper as recently as 1913, and discussed again as a post-war topic last December. It remains for the leading public lighting officials to subscribe to the Society and contribute their quota to the discussions.

Murder Will Out.

As I write, the news comes to hand that the Departmental Committee set up by the Postmaster-General last April to consider broadcasting in all its aspects, has completed its report. The chief recommendations are understood to be (1) the abolition of the present system which requires all sets used under Post Office licence to be manufactured and stamped by British firms affiliated to the B.B.C., (2) the issue of a single Post Office licence at 10s., which will be available for use with any set, whether purchased ready made, or assembled at home, (3) the allocation of 7s. 6d. from each licence to the B.B.C. as compensation for the loss of revenue by the existing tariff on B.B.C. sets as contributed by the maker of such sets.

If the report is accepted and acted upon in its present form we may as well bid good-bye to successful broadcasting and look upon it as a new pastime, fostered by private enterprise and strangled by Government mishandling. If free import of German and other Continental sets and components, of the cheap and nasty order, is to be permitted, then no self-respecting British manufacturer will waste his time or risk his capital in the development, manufacture, or sale of such efficient and rapidly improving apparatus as has been available hitherto. The industry will degenerate into universal factoring of cheap and for the greater part worthless Continental rubbish, and as a natural consequence the popularity of listening-in will wane, because the public as a whole will realise that with such indifferent facilities it is really not worth while. Quite apart from this, the recommendations embodied in the report bid fair to extinguish, at one blow, an already flourishing industry, which was contributing its quota to the relief of unemployment, and throw back upon the dole large numbers of wage-earners in the electrical manufacturing field.

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If the British Broadcasting interests are not sufficiently influential to secure for British industry the fruits of the new pastime by ensuring a rigid embargo on the importation of foreign sets, either complete, or in component form, then it were better by far to abandon the idea altogether and let amateur wireless revert to the position it occupied prior to the introduction of broadcasting as a means of public amusement. The comparatively high prices of some British sets last winter were largely due to the royalties which had to be paid to the B.B.C. In this respect the Committee's recommendations are acceptable since these royalties are to be rescinded. The universal licence is also quite a reasonable proposition, and one which will appeal alike to the genuine assembler of a home-made set and to the man who buys one ready made. The projected raising of the embargo on foreign sets and parts, however, negatives all the benefits likely to accrue from the other decisions and, unless Parliament intervenes with a heavy duty on imported apparatus, wireless manufacturers in this country may as well go out of business right away.

Which reminds me of a story I heard last week based on the exaggerated claims of the average listening-in enthusiast. Three of the latter were comparing notes. Said the first: "With my N.B.G. three-valve set and a Skinnyvox loud speaker I got America last night; had to sit up until 2 a.m., though." Quoth No. 2: "That's nothing; I tuned in on my Ashley two-valve and outfit and clearly heard a concert given in Geelong on the Claritone only yesterday." "I've got both you fellows guessing," said No. 3. "Put my foot out of bed this morning and got Chili!!"

ELEKTRON.

SINGLE-PHASE COMMUTATOR MOTORS.

THEIR PROGRESS AND REASONS WHY THEY DEMAND THE ATTENTION OF POWER ENGINEERS.*

(*Concluded from page* 437.)

It is also found desirable in this type of machine to abandon the mechanical construction of the D.C. motor, with a number of separate salient poles, and to substitute a stator construction similar to that of the induction motor, having a uniform air gap all round, with the winding distributed in slots. This third type of motor is generally known as the repulsion motor, and modern single-phase commutator motors usually start on this principle. Still a fourth combination is possible where the motor is not required to be reversible by means of a controller. The two windings shown in Fig. 3, namely, the field and neutralising winding, may be compounded or combined into a single winding, which is displaced by a certain angle from the magnetic axis of the rotor winding, and this is, for manufacturing reasons, the most convenient method of constructing non-reversible motors.

It is hoped the above discussion will make the relation between the D.C. and A.C. machines, having series characteristics, quite clear. Owing to the independence of the stator and commutator voltage, it is possible to reduce the latter to quite a low figure. This is, of course, one of the two main features relied on to enable us to get perfect commutation.

* A Lecture delivered before the N.A.S.E., by F. Creedy, Esq., A.M.I.E.E., A.C.G.I.

Now let us consider what happens when the motor reaches normal speed, and the rotor circuit is closed. We here come upon a curious inversion of D.C. practice, since whereas in a D.C. compound motor having both shunt and series coils, both of these coils are wound on the stationary member called the field, in the A.C. motor the shunt coil is formed by the rotor circuit through those brushes which are connected to the terminals.

The compensated motor is thus analogous to a D.C. compound motor, having both shunt and series coils, the latter alone being in use at starting, and the former coming into use when the motor is up to speed, the rotor circuit being the shunt circuit. If this is carefully borne in mind, the operation of the machine will be easily understood.

Compounding, for instance, is a very simple process in this type of machine. As normally designed, the shunt circuit is sufficiently powerful to almost completely overcome the influence of the series circuit after the rotor circuit has closed. But by inserting the reactance in the shunt circuit, its strength and relation to the series circuit may be regulated so as to give any amount of compounding desired.

Another view of the action of the machine which, while quite consistent with that just put forward, brings out, perhaps more clearly, the relation between the compensated commutator machine and the ordinary single-phase induction motor, is the following: Ignoring the transformer, assume that the starter merely short circuits the rotor brushes themselves when the motor reaches normal speed. It will then be noticed that the commutator is completely short circuited, both sets of brushes being closed on themselves. It is, therefore, equivalent to an ordinary short circuited squirrel-cage machine, which, having once been brought up to speed, will continue running as an ordinary single-phase induction motor.

The characteristics of such an induction motor would be very inferior, however, and it is to remedy this that the small transformer is employed. This transformer inserts a voltage of some 5 to 10 volts in one of the rotor circuits, which has the effect of completely altering the phase relations of the rotor currents, bringing the power factor of the motor up to 100 per cent. at full load, and increasing the overload capacity very greatly, while at the same time decreasing the slip.

The writer has often been asked by users of this type of machine to explain how it is that it is capable of having its power factor set to the value of unity or even arranged to give a leading current. This is a very difficult question to answer in a simple and intelligible way.

One other type of motor exists having an adjustable power factor, viz., the synchronous motor, whether single or polyphase. This type has a stator winding exactly similar to that of the compensated commutator motor, and a revolving field excited with direct current. Now, imagine this revolving field replaced by a commutator armature with a polyphase distribution of brushes on it, say, three-phase, as shown in Fig. 5. Imagine a polyphase current of normal frequency led through these brushes, and that the rotor is revolving at synchronous speed. These revolving currents produce a revolving field, rotating at the same speed as the rotor, and hence not cutting it. This field therefore will produce no back E.M.F. in the brush circuits, and the current therein will be determined purely by

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Ohm's law, just as it is in the field of the synchronous motor. In fact, the effect of the commutator running in synchronism is to rectify the polyphase current, and supply a constant current in each slot of the rotor winding, this current varying from slot to slot in such a way as to produce identically the same field as that which was before produced by the revolving field of synchronous machine.

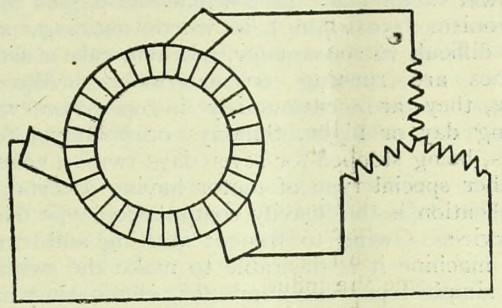


FIG. 5.

The strength of this field may be regulated by varying the applied voltage by means of tappings on a small transformer, just as it is in the synchronous machine of a field rheostat. Hence, from this point of view, the commutator may be regarded as a device for rectifying the field current in the rotor. This, perhaps, gives a fairly simple explanation of the relation between the method of compensating for low power factor by means of the polyphase commutator machine, and by means of the synchronous machine. To explain in detail how compensation is possible with single-phase currents only is beyond the scope of this paper. Briefly, however, the phase of the single-phase current supplied to the commutator by the transformer is split by the action of the revolving armature, so that at no-load the commutator brushes are the seat of a balanced system of polyphase currents. These currents are then rectified by the commutator in the manner just described. (See "Single-Phase Commutator Motors," chap. vi., by F. Creedy (Constable).) It may be stated that in the single-phase motor, as in the polyphase, we have a purely rotating field at synchronous speed rotating with the rotor, and not cutting it. This is the second main feature to which good commutation is due. Since the magnetic field does not cut the rotor, no E.M.F., other than the reactance voltage, which occurs in direct current machines, is to be found in the commutating coil. Hence the commutation of these machines, under normal running conditions, takes place under precisely the same conditions as that of the direct current machines, since motors at all loads run within from 5 to $7\frac{1}{2}$ per cent. of synchronous speed. Before going on to describe some of the more special applications of the commutator machine, to which it lends itself readily owing to its great flexibility, where any other type of single-phase, or, indeed, polyphase, machine would be quite inapplicable, it may be well to complete the comparison with a direct current machine by a brief comparison of the starting arrangements. If the direct current machine were thrown direct on the line, a very large current, 10 to 100 times full load, according to size, would be absorbed, and the machine would, in most cases, flash over from brush to brush. In the single-phase machine, on the contrary, conditions in this respect are more favourable, since it only absorbs two to four times full load current if thrown directly on the line, and there is no tendency to flash over. Hence simpler starting arrangements are permissible. Small machines, say, less than 3 h.p., are usually thrown direct across the line by means of a double pole switch. Above this size the regulations of many supply companies render a starting current, such as that quoted above, objectionable, besides which, where the motor has to start on light load, the acceleration will be far too rapid unless some steps are taken to reduce the voltage at starting. The most convenient method of doing this is by means of an ordinary resistance starter of reduced size and provided with means to close the XX circuit when up to speed.

As an introduction to the study of the adjustable speed compensated machine, let us study how it, a constant speed machine, can be arranged to operate at about 40 per cent. above synchronous speed. Taking the case of a six-pole machine, whose synchronous speed is 800 r.p.m., let us consider how it can be run at 1,160 r.p.m. on 40 cycles.

It has already been pointed out that the field of the motor is a purely revolving one at synchronous speed, exactly similar to that of an ordinary polyphase motor. If we cause a commutator armature to revolve in such a field at varying speeds and observe the voltage across the brushes, we shall see that it is a maximum at starting, gradually decreasing as the speed rises until it reaches the value of zero at synchronous speed. Above synchronous speed the voltage will rise again, and go on rising indefinitely with further increase of speed. If, therefore, we connect across the commutator brushes polyphase E.M.F.s having an equal value to that generated by the armature at any given speed, the motor will continue to run at the same speed, since, as in a direct current or any other type of machine, the constant running speed of the motor is attained when the back E.M.F. is equal to the forward E.M.F. For instance, if the polyphase forward E.M.F. has the value zero, the machine runs at synchronous speed, the only speed at which the back E.M.F.s are zero. Now, the above discussion is only applicable to the single-phase motor on the assumption that steps are taken to ensure that the field is always a purely revolving one. In the compensated type motor this has been brought about by placing an auxiliary winding *AB* on the stator, differing in position by 90 electrical degrees from the main winding, and connected through a small secondary winding on the transformer across those brushes, which are ordinarily brought out to terminals in the motor described previously. The effect of this is to weaken the field of the motor, since, as has already been mentioned, this circuit corresponds with the shunt circuit of the direct current machine, and the effect of such weakening will be to increase the speed somewhat. The increase of speed produced by this means is, however, comparativly slight, and to obtain satisfactory results the rotor brushes, which are ordinarily short circuited, must be brought out to terminals and connected across another secondary winding on the transformer, giving such voltage that the E.M.F.s across the two sets of brushes are equal. Under these circumstances the field will be a purely revolving one, and the explanation given above will also be applicable to the single-phase motor. In order to derive from such a single-speed motor operating at a speed differing from synchronism, a variable speed

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motor capable of operating at a number of distinct speeds, it is clear that all that is necessary is to provide an appropriate switchgear, so that the number of turns on the auxiliary motor winding can be varied. Preferably both these windings should be adjusted simultaneously, in order to maintain a purely revolving field at all speeds as nearly as possible. For manufacturing reasons, however, it is much more difficult to provide a large number of sections in the motor winding than to provide a number of tappings on the transformer secondary.

Connections are, therefore, adopted in which only three tappings are provided on the motor winding and six on the transformer. By this means a sufficient number of combinations to give ten distinct speeds is provided, the field of the motor varying somewhat from the purely rotating character in the majority of these speeds, but in no case more than 15 per cent., the result of which is not very serious. A considerable number of motors built in accordance with the above principles are now running.

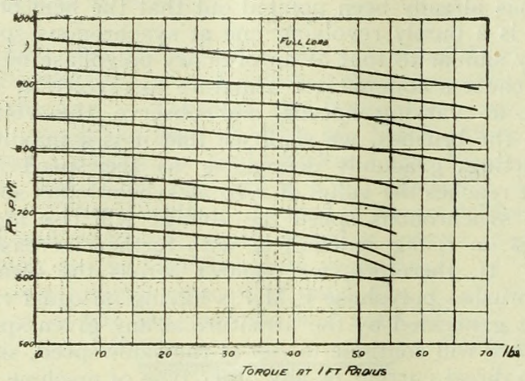


FIG. 6.

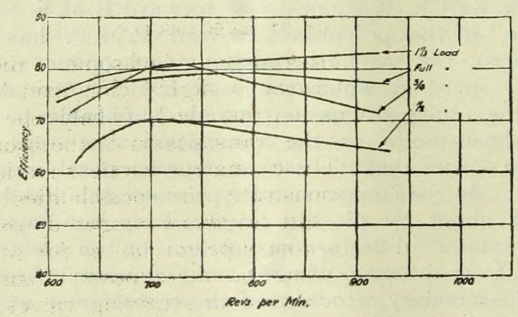


FIG. 7.

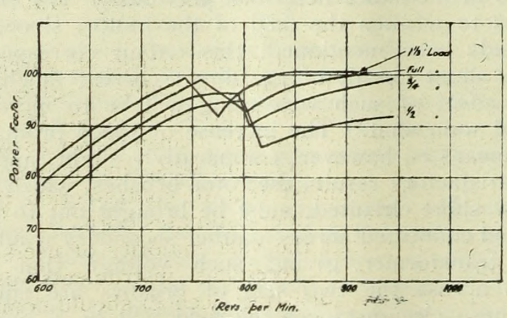


FIG. 8.

In Figs. 6, 7 and 8 are shown the results of a number of tests taken on a machine of this type at the City and Guilds (Engineering) College. The machine in question was rated at 6 h.p. at the lowest speed. This machine was used for printing press driving, and the curves show clearly the close speed regulation as well as the results obtained as regards power factor and efficiency. It will be seen that the efficiency is practically equal to that of a direct current motor, while the power factor averages 95 per cent. over the entire range of speeds. The curious break in the power factor curve as the machine passes through synchronism (750 r.p.m.) is worth noticing, and is rather difficult to account for. In one case a series of machines are running on extremely severe duty, namely, they are continuously in operation without stopping day or night, Sundays or holidays, for six months, being stopped for seven days twice a year only.

Another special type of motor having a certain field of application is the heavily compounded type used for lift service. Owing to frequent starting and stopping of the machine it is desirable to make the switchgear of the simplest possible character, eliminating in particular all time lag devices, which, however satisfactory they may be on direct current, seem to give rise to a considerable amount of difficulty on alternating current. It is explained above how compounding may be effected by the use of self-induction. The special characteristic of the motor, which is attained by the above compound construction, is shown in Fig. 9, which gives

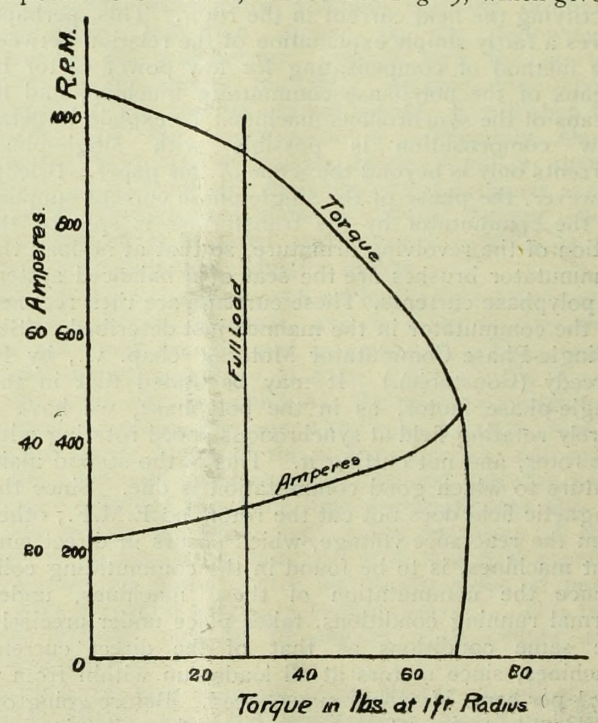


FIG. 9.

a speed torque and speed current curve, which is also the result of tests taken by the City and Guilds (Engineering) College. It will be seen that the speed torque characteristic is a drooping one, showing a considerable speed variation between no load and full load, there being nevertheless a moderate current consumption at starting equal to about $1\frac{3}{4}$ times full load current, with a torque about $2\frac{1}{4}$ times full load. The characteristics, it will be seen, are equivalent to those of a fairly heavily compounded direct current motor. The great advan-

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tage, however, of the single-phase motor being that the motor is switched directly on the line as connected for either one or the other direction of rotation, and will then start with a powerful torque and run up to normal speed without any further change of connections whatever, and without the use of any mechanical device such as a governor, etc. A serious defect of the governor controlled motors is that, owing to the necessary sluggishness governors possess, it is possible for the motor to overshoot and rise above normal speed before the governor operates, the speed being then brought down to normal as soon as it acts. This action, of course, is avoided in a type which is operated without any change of connections from starting to full speed.

I am indebted to the manufacturers of these motors, Messrs. F. and A. Parkinson, Ltd., Netherfield Works, Guiseley, for the loan of the motor and curves exhibited.

[We are indebted to Messrs. Pooley and Austin, the agents for the sale of this particular motor, for the loan of the various blocks used in this article.—Editor, ELECTRICITY.]

FLOODLIGHTING OF WATERLOO BRIDGE HOARDING.

In a recent issue we gave particulars of a hoarding at Chiswick illuminated by G.E.C. floodlights mounted on brackets projecting from the top of the hoarding. This method is employed where the hoarding is of small or medium dimensions, and its location renders the use of bracket mounting necessary, but the scope of such an arrangement is naturally limited. When large hoardings, lying well back from the road or otherwise conveniently situated are to be lighted, it is possible to mount direct floodlight projectors some distance in front. Very considerable economy in current consumption is thus effected, and an extremely even illumination can be obtained. An example of this method of floodlighting is the hoarding in Wellington Street facing Waterloo Bridge, a photgraph of which we reproduce herewith. The hoarding is 40 ft. square, and is illuminated by a battery of five G.E.C. Floodlights type I.E. 2/93, three being equipped with 500-watt Osram gasfilled lamps, and the remaining two with 300-watt lamps. The energy consumption, therefore, is approximately 1.3 watt per sq. ft. The uniformity of the illumination is well shown in the illustration, which is reproduced from an untouched night photograph, while the intensity is all that could be desired. As further testimony to both the efficiency of the installation and the skill of the photographer, it may be mentioned that the background of the *John Bull* panel at the top is painted in yellow—a notoriously difficult colour to photograph.



The G.E.C. floodlight projector used has a substantial copper housing, lined inside with high-grade mirror glass. It is particularly suitable for floodlighting installations where a horizontal beam can be used, and the figures quoted above show that it will give excellent results for a very moderate expenditure of energy. We understand that further information regarding the use of floodlighting, for the illumination either of hoardings or the exteriors of buildings, can be obtained from the Illuminating Engineering Dept. of the G.E.C., Magnet House, Kingsway, W.C.2.

Correspondence.

To the Editor of ELECTRICITY.

"Although the 'ether shaking' of some of these small (amateur) stations is highly commendable, that of others does a great deal to help one to realise how good is the transmission of the broadcasting stations. These amateur wireless stations do, however, demonstrate the possibilities of small-power work; and *telephony ranges of 10 to 20 miles are quite ordinary performances for some of them.* This, using no more power than is required to light three or four receiving valves, is not bad going."—(Extract from article on "Broadcasting," by "Ariel," in the *Daily Mail*, of August 1, 1923, page 5.)

The above extract from a recent article on wireless in a prominent daily newspaper is liable to give the uninitiated a totally false impression both of the efficiency of the average amateur transmission as well as the range of modern receiving sets, and it may be stated without the slightest fear of contradiction that such a statement vastly under-estimates both.

It is a great pity that the vast majority of users of broadcasting sets (*i.e.*, receiving instruments used under the ordinary broadcasting licence) should confine themselves so exclusively to the programmes transmitted by the large stations of the British Broadcasting Company, and neglect the large volume of really good and interesting transmission put out by the various amateur transmitters throughout the country—known

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colloquially as "ten-watters," on account of their transmitting power being usually fixed at 10 watts.

It is possibly this neglect of amateur transmission, and the consequent scarcity of records of results, which accounts for the opinion which is still prevalent among "experimenters" that a broadcasting instrument is less efficient than an experimental set. Whatever may have been the case twelve months ago, since the advent of the R.F.H. reaction sets (manufactured by ourselves), and one or two somewhat similar broadcasting instruments employing non-radiating reaction, we claim that our reaction broadcasting instrument is *superior* to an experimental set as regards results.

Owing to the lack of interest displayed by the broadcaster in anything excepting the programmes put out by the large British and Continental stations, it is very rare that any complete records are available as to what such an instrument will do in the way of reception from the small amateur stations, but we have received reports from users of two- and three-valve R.F.H. sets (H.F., Det. and L.F.) of the following amateur transmissions at the distances named:—

Wakefield (2 AW)	140 miles.
Bramhall (2 DV)	160 miles.
Sheffield (2 IQ)	135 miles.
London (2 JK, 2 LP, 2 OM, 2 SZ, etc.)	105 miles.
Ilford (2 LR)	96 miles.
Hove (2 OJ)	140 miles.
Grimsby (2 QH)	95 miles.
Bedford (2 WD)	90 miles.
Leicester (2 WM)	110 miles.
Ipswich (2 TO)	80 miles.

Though it is not claimed that the foregoing are in any way extraordinary or exceptional results (being merely information contained in casual letters received by the manufacturers from time to time), we think that the figures are worthy of publication at the present time to show that broadcast receiving sets are not so inefficient in range, nor the amateur transmissions so poor, as might be imagined from a perusal of such statements as the one quoted above.

We shall be delighted to furnish any further information which you may require, and remain,

ROGERS, FOSTER AND HOWELL, LTD.
P.p. A. J. SMITH.

Edward Road, Balsall Heath, Birmingham,
August 21, 1923.

Meetings.—The first meeting of the new session of the Inst. of the Rubber Industry will be held in the Kelvin Room of the Engineers' Club, Coventry Street, London, W.1, at 8 p.m. on Monday, September 17, when Mr. E. J. Edwards will read a paper entitled "Rubber Floors and Rubber Roadways." As rubber floors and mats are of direct interest to all in charge of high-tension plant, it is probable that the paper will appeal to many electrical engineers. Tickets may be obtained on application to Mr. W. T. V. Cox at Faraday House, 10, Charing Cross Road, London, W.C.2.

"**The Professional Photographer**."—This is the title of a beautifully printed monthly issued by Kodak, Ltd., of Kingsway. The July issue contains an article on Messrs. Avery, Ltd., the well-known manufacturers of weighing machines, concerning the use of photography for commercial purposes, which will interest many of our readers, as the arguments in favour of the use of photographs can be applied to any business, and they are being used for publicity purposes much more largely than formerly. Copies can be obtained by applying to the Wratten Division of Kodak, Ltd., Kingsway, W.C.2.

TELEGRAPHY.—GRADE I. (1923).*

Being Solutions to the Questions set by the City and Guilds of London Institute in the Grade I. Examination in Telegraphy held in May, 1923.

(*Continued from page 447.*)

Q. 11.—Describe, with a sketch, the construction of a submarine cable. What is the difference between a shore-end cable and a deep-sea cable? How would you localise a full earth fault on a deep-sea cable?

A. 11.—As a rule submarine cables are designed of three types, according to the depth of water in which the cable will be laid and the nature of the bottom. The deep-sea type has an overall diameter of about 1 in., and is used for depths exceeding 500 fathoms. The intermediate type is larger in diameter than the deep-sea type, and is used for depths beween 30 and 500 fathoms. The shore-end type has a diameter of 2 in. or more, and is used for depths up to 30 fathoms.

Fig. 6 shows a section of a typical submarine cable of the intermediate type. The conductor consists of seven stranded copper wires weighing 200 lb. per knot, and it is covered with gutta-percha also weighing 200 lb. per knot. Around the core thus formed is

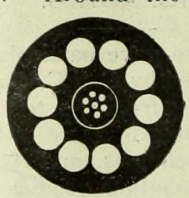


FIG. 6.

wound brass tape, 4 mils. thick, as a protection against the *teredo*, a submarine boring worm. Surrounding the brass tape is a serving of *tanned* jute yarn to take 10 galvanised iron wires, each 280 mils. in diameter. The iron wires are covered with a serving of *tarred* jute, then compound, tarred jute again, and finally another serving of compound.

The resistance and capacity per knot of such a cable is about 6 ohms and .35 microfarads respectively.

Owing to the liability of wear from chafing on the bottom, and to risk of being damaged by the anchors of vessels passing over it, it is necessary that shore-end cables should be very much stronger than the deep-sea type, and for this reason the galvanised iron sheathing wires used are much heavier. In some cases two layers of sheathing wires are used.

The conductor of cables is made of stranded wire in order to give it flexibility and render it less liable to be fractured.

The core of a cable is always of the same gauge throughout its entire length, and is usually made in lengths of about two nautical miles.

A full earth on a cable is the simplest fault to localise, and, assuming that such a fault has no resistance, its distance from the testing station may be ascertained by simply measuring the apparent conductor resistance of the cable either by the Wheatstone Bridge or Megger in the usual way. As an example, suppose a cable has

* *The standard text books for this Grade are: "The Telegraphists' Guide," by Bell & Wilson (20th thousand, 3s. 6d. net); and "Questions and Solutions in Telegraphy and Telephony, Grade I.," by Few (5th edition, revised, 5s. 6d. net).*

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a conductor resistance of 6 ohms per mile, and that, with a full earth fault on the cable, the measured conductor resistance is 840 ohms. The latter number represents the total resistance of the conductor from the testing station up to the fault, and, as the resistance per mile is 6 ohms, the distance of the fault from the testing station is

$$\frac{840}{6} = 140 \text{ miles.}$$

(To be continued.)

ELECTRICAL ENGINEERING—FINAL GRADE.

SOLUTIONS TO 1923 EXAMINATION QUESTIONS OF THE CITY AND GUILDS INSTITUTE.

BY EDWARD HUGHES, B.Sc. (Eng.) A.M.I.E.E.

(Continued from page 435).

Q. 5.—Draw the diagram of connections for a 3-phase induction regulator for regulating the voltage at the receiving end of a transmission line.

The voltage at the end of a feeder transmitting 100 kilowatts varies between 475 and 525 volts. For how many kilovolt-amperes must an induction regulator be designed to maintain the pressure constant at 500 volts?

A. 5.—Fig. 7 shows the necessary arrangement; *PPP* represent the primary windings connected in star, and *CCC* are the secondary windings connected in

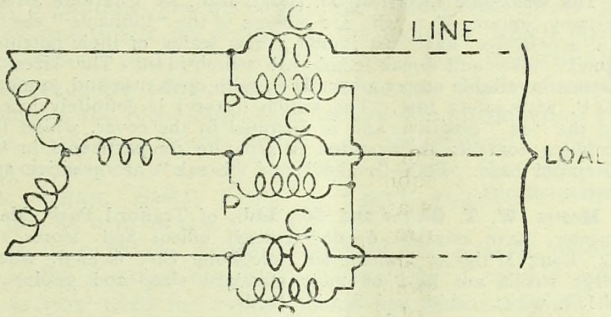


FIG. 7.

series with the line conductors. These are arranged exactly as in the case of an induction motor, the secondary winding being usually on the stator owing to the two ends of each phase of the secondary having to be brought out. The rotor, however, is not free to rotate, its position being usually controlled by a small reversible motor operating through a worm gearing. The rotor currents give rise to a magnetic field rotating at synchronous speed and therefore inducing in each phase of the stator winding an e.m.f. of magnitude *AB*, say, in Fig. 8. The phase of this e.m.f. in relation to the corresponding phase voltage *OA* of the alternator can be altered by shifting the rotor winding of the induction regulator relatively to its stator winding. The magnitude of the secondary e.m.f., however, is not thereby altered. Hence if the secondary e.m.f. with a given setting of the rotor be represented by *AB* in Fig. 8, the voltage between the star point of the alternator and the load side of the regulator is given by *OB*. By altering the position of the primary windings *P* in relation to the secondary windings *C*, the resultant voltage can be varied between the minimum *OD* and the maximum *OE* (Fig. 8).

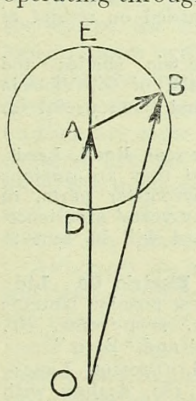


FIG. 8.

In the example referred to in question,

$$\text{current per line} = \frac{100 \times 1{,}000}{1.73 \times 500} = 115.3 \text{ amps.,}$$

the P.F. being assumed to be unity.

Also the line voltage is to be varied by 25 volts above or below the average voltage, so that the voltage to be induced in each secondary phase of the induction regulator is $\frac{25}{1.73}$, and the k.v.a. of each phase therefore

$$= \frac{115.3}{1{,}000} \times \frac{25}{1.73}$$

Hence, total k.v.a. of induction regulator

$$= 3 \times \frac{115.3}{1{,}000} \times \frac{25}{1.73} = 5$$

This answer could have been derived directly from the fact that the induction regulator may have to supply 25 volts out of the 500 volts required to transmit the 100 k.v.a., so that the k.v.a. of regulator $= 100 \times \frac{25}{500} = 5$. This method, however, does not indicate as clearly as the first the manner in which the regulator contributes its power.

(To be continued.)

Questions and Answers by Practical Men.

RULES.

QUESTIONS: *We invite our readers to send us questions, preferably on technical problems that have arisen in actual practice. Questions which we consider of sufficient interest to our readers will either be replied to under "Answers to Correspondents" or replies will be invited from our readers. One shilling will be paid for the question which we select for competitive replies in this column.*

ANSWERS: *A fee of 10s. will be paid for the answer which we consider shows the greatest merit, and 5s. for the one we select as second best. In judging the replies, importance will be attached to clearness and conciseness, as well as accuracy. The Editor reserves the right to make no award, or to accept only one reply, if, in his opinion, the answers received do not possess sufficient merit. Competitors desiring the return of their manuscripts, if unaccepted, should enclose stamped addressed envelope.*

Write on one side of the paper only, and if diagrams are sent, draw them on a separate sheet of paper attached to the manuscript. Competitors may adopt a "nom de plume," but, both in the case of questions and answers, the competitor's real name and address must be sent with the manuscript as a guarantee of good faith. No correspondence will be entered into with regard to successful replies. The Editor's decision is final.

Commencing with Question No. 101, *a Diploma of Merit will be awarded to the six competitors who win the first or second prize the most times during the next twelve months.*

The words "Questions and Answers" or "Q" and "A" should be placed at the top left-hand corner of all letters intended for this column.

QUESTION NO. 167.

I have a large bell in my works used to signal the "commence work" and "cease work" to my employees. At present it is operated by hand. Can I electrify this so that it will work if I press a button? If so, I would appreciate the details.—"CASHIER."

QUESTION NO. 168.

I wish to convert a 220 volt D.C. motor to one of 100 volts. The machine is 4-pole, wave wound, 10 b.h.p., 750 r.p.m. Can you give me the full details to enable me to carry this conversion out?—"WINDER."

(Replies to Questions Nos. 167 *and* 168 *must be received not later than September* 29, 1923.)

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1,000 TONS OF MACHINERY AT OLYMPIA.

In preparation for the Shipping Exhibition, which opens to-day at Olympia, considerably over a thousand tons of machinery, mostly to be shown in operation, are being installed. Giant traction engines, fitted with cranes in front, have been employed to deal with the heaviest and most bulky pieces, while fifteen cranes and gantrys, capable of lifting up to six tons at a time, are in use, and hydraulic jacks help to place big weights into position.

There will also be on view full-sized sea and river boats, the newest motor lifeboat lent by the National Lifeboat Institution, models of royal yachts supplied by the Admiralty, lighthouses and lightships from Trinity House, a ship's boat raised sixteen feet to demonstrate method of launching in a storm, Marconi wireless telephone operating fifty miles from the shore, sections of steamers for the public to explore and an enormous model of the Port of Liverpool, lent by the Mersey Docks and Harbour Board. The Society of Motor Manufacturers have made a most interesting collection of full-sized motor boats, which will be shown in the new hall.

Thirty-five leading bodies of engineers, shipbuilders, electricians and metallurgists will pay official visits to the Shipping Exhibition, the largest and most complete ever organised, and, in addition to the Continent, the American Foundrymen's Association is sending a delegation. The public will be admitted daily to the Exhibition, which remains open for three weeks.

Various Items.

"**When Daylight Fades.**"—This is the title of a new leaflet issued by E.D.A. It is neatly worded and well printed, so should help enterprising contractors to get more work during the coming autumn.

Hearty Congratulations.—On Friday, August 24, at St. Martin-in-the-Fields, Flossie May, only daughter of Mr. and Mrs. J. W. Elliott, lamp sales manager the Edison Swan Electric Co., Ltd., was married to Mr. Richard Michael Clark, M.C., B.Sc., second son of Mr. and Mrs. Clark, of Brentwood, Essex.

Good News.—At the last meeting of the L.C.C. held on July 31, the following resolution was adopted, on the motion of Mr. C. A. G. Manning, a member of the Labour Party on the Council: "That it be referred to the Education Committee to consider and report whether or not at appropriate centres cooking by electricity should be taught." Let us hope the suggestion will be adopted.

University of London.—A Goldsmid entrance scholarship of the value of £120, tenable in the Faculty of Engineering of University College, London, will be awarded in September, and entry forms must be received by the Secretary of the College not later than September 8. In connection with the examination for the scholarship, five bursaries may be awarded to engineering students who require financial help to enable them to take a University course in engineering.

Aircraft Apprentices for the Royal Air Force.—We have received a communication from the Air Ministry announcing the decision of the Government to increase the strength of the Royal Air Force for Home Defence purposes, thus necessitating the engagement of aircraft apprentices, who will be trained as skilled craftsmen, in largely increased numbers. For the entry in January next approximately 950 boys of a good class will be required. The selection to fill these vacancies will be made on the results of two competitive examinations. The education authorities will be asked to co-operate in this movement. Headmasters and others interested in the scheme can obtain copies of the regulations for entry (A.P. 134) on application to the Secretary, Air Ministry, Kingsway, W.C.2.

Lathe Tools.—An advertiser has for sale an assortment of lathe tools for high-speed work, which he is offering at bargain prices. For particulars, see small advertisements, page vii.

Egypt.—The Report on the Economic and Financial Situation of Egypt has just been issued by the Dept. of Overseas Trade, and may be obtained from H.M. Stationery Office (or ELECTRICITY Office), price 1s. 8d. post free. It will interest all manufacturing electrical firms who are anxious to push their goods in the Egyptian market.

Trade Notes.

We are in receipt of a catalogue issued by **David Bridge and Co.**, Castleton, Manchester, which is one of the best compiled works we have had the pleasure of handling for some time. It is of 132 pages, printed in black on art paper, with a strong scarlet cover specially designed for hard wear, and the contents will be found specially interesting and very useful to engineers. It deals with the products of David Bridge and Co., whose reputation for millgearing is well known. The outstanding feature is the considerable amount of space devoted to technical data, which will be found to be very useful. Persons interested in millgearing, friction clutches, pulleys, etc., would be well advised to write for a copy.

"Silent Record" engines, which are designed to run on petrol, paraffin or gas, are available in all the usual sizes for driving line shafts, dynamos, motor boats, agricultural machines, etc. In the four-cylinder engine there are only two piston valves, requiring no adjustment, worked directly from the crankshaft. A two-cylinder engine in sizes from 1½ to 225 b.h.p. is made for direct coupling to a dynamo. Particulars of this and other types can be obtained on application to the **Record Engineering Co., Ltd.**, of Tutbury, Burton-on-Trent, at their London office, Donnington House, Norfolk Street, Strand, W.C.2.

The Wholesale Electrical Co. (1922), Ltd., 78, Charlotte Street, Fitzroy Square, W.1, who are makers of the "Pinnacle" electrical accessories, have just issued a new leaflet of their patented quick make and break combined switch-fuse. The sizes at present available are 15 amps. D.P. with open fuse and 30 amps. D.P. with safety fuse. The switch (rotary) is definitely locked in the "on" position, and is mounted in the cover, whilst the rubbing contacts are mounted in separate compartments in the fireproof base. Both "make" and "break" are positive and instantaneous.

Messrs. W. T. Glover and Co., Ltd., of Trafford Park, Manchester, have recently opened branch offices and stores at 14, Long Millgate, Manchester (telephone City 6230-3), where large stocks are held of their standard sizes and grades of V.I.R. wires, cables and flexible cords.

Circulars 1297/1, "Type S Automatic Oil Break Ironclad Switchgear"; 1299/1, "Flexible Unit Type, Air Break Ironclad Switchgear"; also leaflets 301/7-1, "Panel Type Switchboards"; 301/8-1, "Sheet Steel Cubicle Switchboards"; 17/1-1a, "Direct Current Commutating Pole Motors, Type X"; and 17/1-1d, "D.C. Commutating Pole Motors and Generators, Type X," have been issued by the **Metropolitan-Vickers Electrical Co., Ltd.**, of Trafford Park, Manchester. They give clear descriptions, with excellent diagrams, of the various types of switchgear and apparatus referred to in each list, and should be of direct value to all central-station engineers and installation contractors. They will be forwarded on receipt of proper trade application.

Leaflets illustrating various types of electric shades and glassware have been issued by **Mr. F. Pratt**, of 66, Victoria Street, London, S.W.1. Contractors will find them useful for reference, and should obtain copies.

From the **Bowen Instrument Co.**, of 9, Newton Road, Leeds, we have received a circular announcing that they are anxious to receive inquiries for pyrometers and pyrometer parts, in the manufacture of which they have had many years' experience. Price lists are in course of preparation, and will be sent to interested readers on application.

In a new illustrated leaflet the **General Electric Co., Ltd.**, announce reduced prices of three of their most popular lanterns for the lighting of streets, railway yards, shop-fronts, etc. The lanterns are the "City," "Birmingham," and "Boro."

British Insulated and Helsby Cables, Ltd. (Prescot, Lancs), have just issued a new pamphlet, No. P. 180, dealing with Prescot aluminium matting and sections, and aluminium and copper sheets.

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ELECTRICITY
A PRACTICAL TRADE JOURNAL

SEPTEMBER 7, 1923.

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THE LIMITATIONS OF RHEOSTATIC CONTROL OF ELECTRICAL MACHINERY IN MINES.

By C. Sylvester, A.M.I.E.E., A.M.I.Mech.E.

The application of electrical machinery and apparatus to mining has developed so rapidly that there is now practically no section of the industry which does not depend upon electricity, more or less, to facilitate and expedite production. Of recent improvements, some of the most important include the introduction of the explosion proof motor and switchgear. Such developments are very welcome because the logic of the slogan "Safety First" is equally applicable *down below* as it is *on top*.

It is, perhaps, in the design of the electric motor that the greatest developments have been carried out. It is now used for driving purposes and is applied to main winding, pumping, hauling, coal cutting, ventilation, conveying, screening, coal washing and many other purposes where increased efficiency is desired. Of these, the most important is the application of the motor to main winding. It is not only reliable, but more efficient from the fact that full torque can be developed very quickly with smooth speed and acceleration.

There was a time, and not so very long ago, when the motor for the main winding plant in a mine was looked upon with disfavour. At that time there was not a great deal to recommend it, because the breakdowns to motors were very frequent. Breakdowns to motors are now almost a thing of the past, since the designs are so varied that they can be obtained to meet the most severe requirements. In addition, they are designed to operate in extremely hot or cold, and wet or dry, places, and the result is general satisfaction.

Although we have no cause for complaint concerning the design and construction of the main winding motor, the same cannot be said of the control apparatus. The same progress has not been made, and one often hears complaints in this direction. The control system of a main winding plant in a mine must be absolutely reliable at all times. The design should be such that all parts of the apparatus will withstand the most severe, in fact, one may say, most unreasonable, conditions of service without giving trouble, or without the maintenance man having to be continually in attendance in case of breakdown. It should be absolutely foolproof, and this, in effect, means that it should be impossible for the operator to damage the motor, controller or any part of the machinery by a wrong action brought about by a misjudgment of conditions.

It may be said that these demands are made of electrical control apparatus in general. This is so, but it must be understood that the conditions at a mine are not the same as with ordinary power plants. The average power plant is, as a rule, under the supervision of an efficient maintenance staff. There are a certain number of *spares* always to hand to be used at a moment's notice. With material and efficient labour it is quite easy to cope with any breakdown. The motor for the main winding plant of a mine has to be specially designed to meet certain requirements. The motor for one mine would not be satisfactory if called upon to replace one at another mine, and the same may be said about the control apparatus. Therefore, although the available spare parts may take the form of a spare armature and field coils for the motor, and probably a few contacts for the main controller, such things as resistance grids, levers, no-load units, etc., cannot be economically stocked in large quantities. The remedy appears to be in the better and more efficient design of the apparatus.

Again, as stated above, the maintenance staff of the average power plant consists of a number of efficient electrical fitters, etc. There are mining electricians, and these are efficient when dealing with ordinary electrical mining apparatus, such as induction motors, coal cutters, signalling apparatus or shot firing dynamos. They, however, know very little about the technical details of the control apparatus of the main winding plant, and the fault is not their own. They have no opportunity to study the design of electrical apparatus as applied to mines. I have known mining electricians to attend their local technical school for the full five years' course in electrical engineering, and they have not been taught anything about electricity as applied to mines. The ordinary power plant electrical fitter knows no more about mining electrical apparatus than the mining electrician does, and the latter knows quite as much about ordinary electrical apparatus as the former. From this it will be gathered, since labour and material are not available, that main winding equipment should be so designed that continued successful operation is secured. Delays in operation through breakdown mean tremendous losses to mining companies.

The electrical control of large motors for main winding is very complicated, since there are so many features to be considered. The embodiment of all the desirable features which go to make the efficient system are worthy of serious consideration, because the advantages are very numerous. At the present moment the control of electrical machinery is limited, especially where rheostats and resistances are employed. Before one can form any definite opinion concerning the limitations of control, it is necessary to consider existing methods from several aspects.

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Under ordinary conditions, when the electric power supply to a motor is taken off, the motor speed will gradually diminish, due to the friction load, and the motor will stop. By this method the time required to bring the motor to a standstill is generally too long for practical purposes, so other means have to be applied. These means may take the form of applying brakes mechanically, electrically or by hand, or by rheostatic control with the aid of alternating or direct current. With modern equipment rheostatic control is generally adopted. If direct current motors are used for main winding, then the braking operation takes the form of regenerative control, such as is used on traction systems. Here, when the supply is disconnected from the motor through the controller, the motor acts as a generator and supplies current to a resistance. The value of this current, or load on the "generator," depends upon the amount of resistance inserted. This current, when passed through a solenoid connected to a brake, makes the system much more efficient.

The majority of motors used in main winding equipment, however, are induction motors. This makes the control much more complicated, as is quite clear when the characteristics of the motor are considered. The induction motor may be likened to the transformer in every way. The stator winding is the primary winding, and the rotor is the secondary winding. Any change in current in the rotor circuit will instantly react upon the stator circuit. Thus a decrease of speed of the rotor, due either to load or mechanical braking, means an increase of current through the rotor circuit, because the speed is now much below synchronism. This, in turn, means a correspondingly increased amount of current through the stator circuit from the supply mains.

From this it is clear that an induction motor cannot be controlled by this method unless a considerable amount of current is taken from the mains, and this is not desirable. If the control is to be effected with alternating current, it is necessary to reverse the rotating field of the motor. In a three-phase motor this is done by reversing any two leads connected from the supply to the stator winding. At the moment the motor is reversed, assuming the motor to be running near synchronous speed, the frequency in the secondary winding is almost twice that of the primary winding. Now, since the voltage of the rotor winding changes in the same ratio as the rotor voltage, this voltage will be twice the voltage at standstill. This makes is necessary for the insulation of the rotor winding to be insulated, so that it will stand up against the increased voltage. It is true that, on small machines, the stationary voltage is so low that the insulation is strong enough to withstand the double voltage under the necessary operating conditions. With large motors, however, the rotor winding has to be designed for higher voltage in order to avoid large currents.

This is not desirable by any means, because a higher voltage requires more insulation, and this means increased difficulties in the way of efficient design. On the other hand, a larger current means much larger apparatus, such as switches, cables, etc. It is true that, with a star winding, the insulation of each phase to earth can be reduced by earthing the neutral point, but this does not affect the insulation between phases, and it is this that matters. Owing to these disadvantages, braking with alternating current is not often resorted to.

Referring to Fig. 1, this illustrates the method of control with direct current applied to a three-phase induction motor. The winding represents the stator circuit which is connected in star. Here A, B and C represent three different methods of connection. Referring to A, the current passes through two phases in series. In B, one phase is in series with the other two phases in parallel. In C, all three phases are in series.

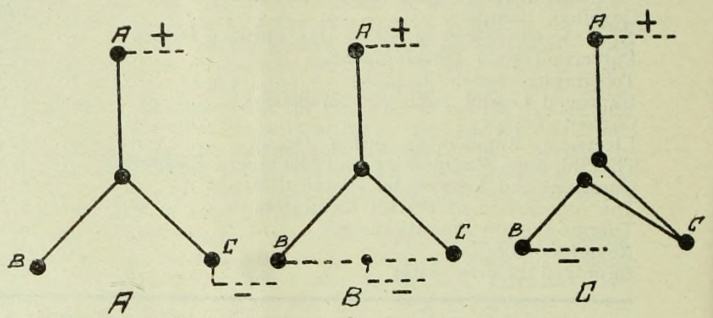


FIG. 1.

Fig. 2 illustrates the application of direct current to a delta connected motor. Here, at A, the current passes through a joint circuit of one phase, and two phases in series, in parallel. The current through the single phase will be twice the amount of that through the other circuit. At B, the current passes through two phases only. At C, the three phases are in series. Of both the star and delta connections, A in each case is to be preferred, owing to their permitting the simplest switching arrangements.

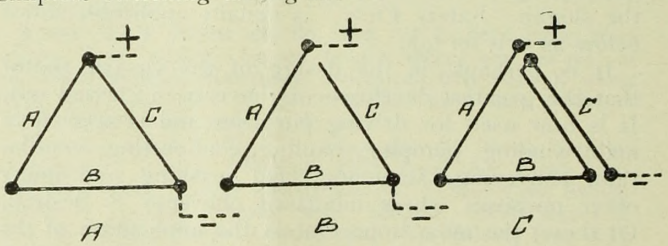


FIG. 2.

No matter how sound a method of control may be, if the means of applying the method is not sound then the object for which the method was produced is defeated. The application of direct current for braking induction motors is a sound proposition, but the means of applying the method is faulty. It has limitations from the fact that the control of this current is by means of a rheostat, and resistance is not immune from breakdown. Let us consider for a moment the advantages of liquid and metallic resistances as applied to rheostatic control.

(To be continued.)

Price Changes in Germany.—The Association of Electric Cooking and Heating Apparatus Manufacturers has given notice that as from August 15 the prices of electric cooking and heating apparatus will be calculated in gold marks. They will be based on the catalogue prices of March, 1922, with a gold factor of 0.024 for heating irons, cords and travelling apparatus, and of 0.020 for all other kinds. One gold mark equals one dollar divided by 4.20

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GASFILLED LAMPS.

Reduction in Prices

A general reduction in prices of gasfilled lamps is announced by the E.L.M.A. as having come into force on the 1st inst. It will be seen from the advertisement pages that the reductions cover all gasfilled lamps for circuits of 100/130 and 200/260 volts. It is interesting to note that although largely developed during the war, British firms were unable to obtain facilities for manufacture in large quantities until after 1918. The present is the third price reduction since 1920, and is due this time to improved factory efficiency, the labour market not having cheapened since the previous reduction—twelve months ago. Further, gasfilled lamps are protected by British patents, and therefore free from competition.

The trade in gasfilled lamps now represents more than half the total trade in metal filament lamps.

The trade names of lamps made by members of the E.L.M.A. are Mazda, Royal Ediswan, Siemens, Osram, Cosmos, Elasta, Foster, Stearn, Cryselco and "Z."

NEW DEVELOPMENTS IN STEAM JET FURNACE DESIGN.

The principle of the steam jet type forced draught furnace is an extremely good one, especially for smaller boiler plants and in connection with the use of many kinds of inferior fuel, but it is absolutely essential to have a correct scientific design. Two of the inherent defects of the ordinary steam jet furnace are the excessive consumption of steam at the nozzles and the unequal forced draught at different points of the grate. In this connection some tests just carried out by the staff of a large steel works on the working of the "Turbine" furnace are of great interest, and for the first time give some really unprejudiced data.

These tests have proved that the steam consumption was 3.1 per cent. of the production of the plant, practically only equal to mechanical draught, whilst having, of course, the advantage that the steam protects the bars, giving many years' life instead of the usual twelve months. Also the curve of the intensity of the air blast at every stage of the bar length is a dead straight line, a remarkable tribute to the efficiency of the "Turbine" design, based on the principle of the de Laval steam turbine, as in most steam jet furnaces there is a suction for about the first two feet and a great increase of pressure at the back, whilst also the sides are obtaining much more air than the middle.

The "Turbine" furnace has now been adapted to work with vertical boilers, even of the smallest size, and there is no longer any reason why every boiler, even with only a fuel consumption of several tons per week, should not now be worked at a reasonably high efficiency. Also, it has been proved that this furnace is very suitable for marine conditions. Thus, for example, the Vancouver Ferry Board have recently fitted it on their steamers and exhaustive tests have given the most highly satisfactory results, enabling full steam pressure to be kept up on cheap slack coal and actually giving a net reduction in the total coal bill of from 45,895 dollars per annum to about 26,000 dollars.

Finally a very important new modification of the "Turbine" furnace is claimed to have solved the problem of burning fine refuse anthracite coal which would represent a revolution in steam generation in all districts, particularly South Wales, containing anthracite fuel. As is well known, anthracite, even in large lumps, is somewhat difficult to ignite, but when in the dust form, "culm" or "duff," it has proved an almost hopeless proposition. Thus the fine dust chokes the draught, and, in spite of this, the bars have to be very close together or else the material falls through. Also, if mechanical draught is used, the only result is to blow the fuel off the bars unburnt, because it is so light.

The modification of the "Turbine" furnace devised for this purpose is to substitute the small ⅛-in. air slits between the small bars or elements in the standard design with a row of very tiny holes or slots, so that a grate surface of a Lancashire boiler, 30 ft. by 8 ft., contains about 2,000 of these slots. The result is the draught is so subdivided that a proper forced blast does not blow the material off the bars, and standard Lancashire boilers are now working in South Wales evaporating over 5,000 lb. of water per hour with anthracite refuse fuel only, the importance of which can hardly be exaggerated.

PULVERISED FUEL DEVELOPMENTS

The recent report on pulverised fuel submitted by Mr. S. W. Baynes, the chief engineer at the St. Pancras station, to the Electricity Committee of the St. Pancras Borough Council, is a welcome indication that British power-station engineers are alive to the remarkable growth of pulverised fuel in the United States. We understand that the Electricity Committee have recommended to the Council, in view of the great extensions pending at the King's Road Power Station, St. Pancras, that the chairman of the Electricity Committee (Alderman J. H. Mitchell, J.P.) and Mr. Baynes be empowered to visit the United States and inspect a number of the largest American power stations with a view to the possible adoption of pulverised fuel at St. Pancras.

As is well known, pulverised fuel, on the "Lopulco" system, has made extraordinary progress in the United States since the success of the pioneer large power station installation, the "Lakeside" plant of the Milwaukee Electric Railway and Light Company, on Lake Michigan, of which 40,000 kw. was started-up in December, 1920, with other 40,000 kw. now in course of erection, the station being designed for ultimately 160,000 kw. normal or 200,000 kw. long-distance overload.

The results obtained have exceeded expectations, and the plant is running from month to month at 85 per cent. to 86 per cent. efficiency, the figures being published regularly, with a total expenditure of auxiliary power for handling, crushing, drying and pulverising of 1.75 per cent. of the steam production, and with, it is claimed, less labour, wear and tear, depreciation and repair costs than mechanical stoking.

This figure of 1.75 per cent. includes approximately the equivalent of 1 per cent. of the steam production for drying the coal in the horizontal revolving double cylindrical dryers used. Within the last twelve

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months, however, this type of dryer has been superseded by a new type of vertical drier using only 10 per cent. of the hot waste chimney gases and taking 3 kw. per ton of coal for mechanical fan to circulate the gases, so that the total auxiliary power is now only about 1 per cent. of the steam production. The success of this pioneer installation has led to an extraordinary development of pulverised fuel in America, and the first European installation will be the one now being erected at Vitry, Paris, four huge boilers of 160,000 lb. per hour evaporation each.

Finally, one other point should be noted—the idea possessed by some British engineers that pulverised fuel is still somewhat of an "experiment." The best reply to this is—a station of the size and importance of "Lakeside" has certainly not been running for nearly three years at over 85 per cent. efficiency with any system that can be regarded in the nature of an experiment, and the facts that very shortly several million tons of coal per annum will be consumed in the pulverised condition on power-station plants alone, and plants such as the Ford installation at the River Rouge; the Cahokia station, St. Louis; the Cleveland Electricity Company; and the Detroit Edison Company, have adopted it—that is, some of the largest and most efficient stations in the world.

TELEGRAPHY.—GRADE I. (1923).*

Being Solutions to the Questions set by the City and Guilds of London Institute in the Grade I. Examination in Telegraphy held in May, 1923.

(*Continued from page 465.*)

Q. 12.—A perfectly insulated line of 640 ohms resistance is worked double current duplex. Batteries of 37 ohms internal resistance are used at each station. Give a diagram of the circuit showing the values of the resistances of the coils of the instruments used, and calculate the value of the resistance required in the compensation circuit rheostat to obtain a balance.

A. 12—Fig. 7 shows in skeleton form a double current duplex circuit.

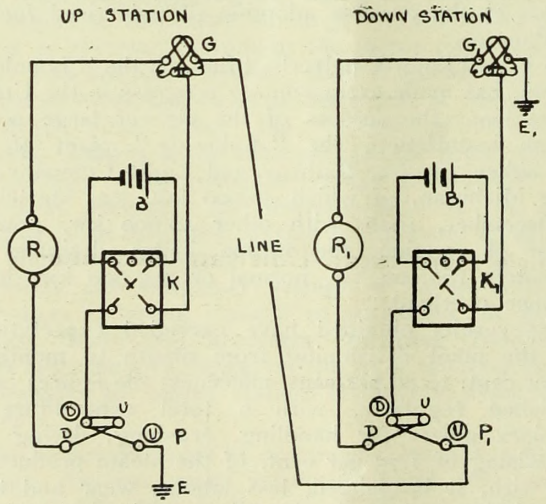


FIG. 7.

* *The standard text books for this Grade are: "The Telegraphists' Guide," by Bell & Wilson (20th thousand, 3s. 6d. net), and "Questions and Solutions in Telegraphy and Telephony, Grade I.," by Few (5th edition, revised, 5s. 6d. net).*

G, G_1 are differential galvanometers, the coils of which have each a resistance of 50^{ohms}, and each coil is shunted by a resistance coil of 300 ohms. The joint resistance of each coil of the galvanometers is therefore

$$\frac{50 \times 300}{50 + 300} = 42.9, \text{ say } 43 \text{ ohms approx.}$$

B, B_1 are the main batteries each of internal resistance 37 ohms.

P, P_1 are polarised relays, the coils of which are each 100 ohms.

R, R_1 are the compensation circuit rheostats, the value of whose resistance it is required to find.

Working from the up-station battery B, then the total resistance of the compensation circuit is equal to

1 coil of G + rheostat R + 1 coil of relay P.

Also the resistance of the line circuit is equal to 1 coil of G + line resistance + 1 coil of relay P_1 + battery B + 1 coil of G_1 + earth resistance (including earth plates at E_1 and E) + 1 coil of relay P.

(Actually, the line coil of relay P_1 and the battery B_1 are shunted by the compensation coils of P_1 and G_1 and the rheostat R_1, but the effect on the resistance of the line circuit may be neglected for simplicity.)

Assuming that the earth resistance is negligible, then, since the line and compensation circuits must be of the same resistance, it follows from the preceding that

Rheostat R = line resistance + 1 coil of relay P_1 + battery B_1 + 1 coil of galvanometer G_1.

Substituting the various numerical values given, then,

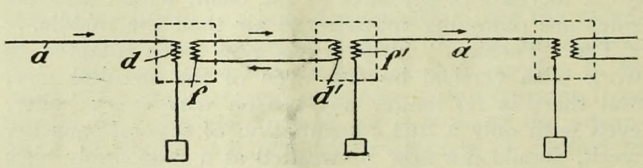
Rheostat $R = 640 + 100 + 37 + 43 = 820$ ohms.

Hence the resistance required in each compensation circuit rheostat to obtain a balance is 820 ohms.

(To be continued.)

IMPROVED LEADER CABLE FOR NAVIGATION.

An interesting development of the use of a submarine cable carrying alternating current, as a guide to ships traversing narrow waters in darkness or fog, has been patented by Siemens and Halske (German Pat. No. 348,874). The aim is to make possible the recognition of definite points along the route, and for this purpose induction devices are inserted in the line *a* carrying the alternating current, so that—without affecting the transmission of the current—its effect on the receiving devices carried by the ship can be varied, weakened or interrupted at will.



The inductive device may be a loop in the line *a*, or it may be a transformer, and the arrangement of these devices can be varied so that the navigator receives distinctive signals telling him his exact position along the channel. It would appear that this simple amplification of the plain leader cable increases the utility of the system very considerably without detracting from its simplicity and reliability.

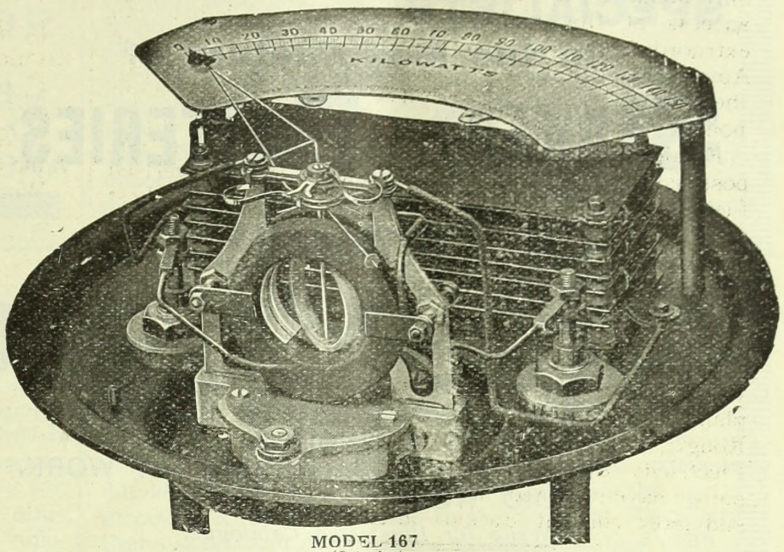
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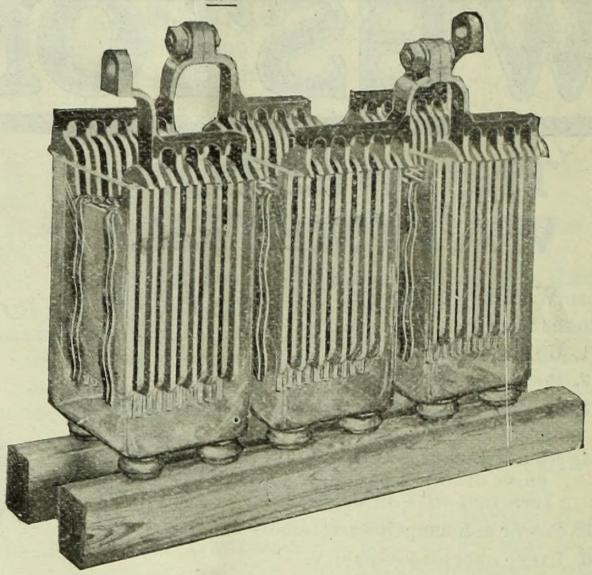
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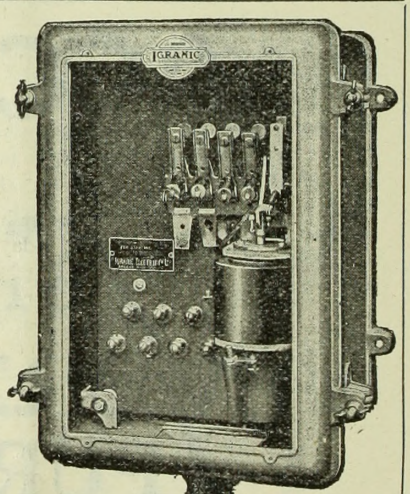
Programme for the complete session is ready and can be obtained on application by letter to the Director and Secretary, E.D.A., 15, Savoy Street, London, W.C.2.

N.B.—The first meeting of the series will be held on Friday, Sept. 21st, 1923, at St. Bride's Institute, Bride Lane, Ludgate Circus, E.C.4

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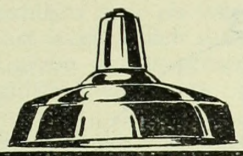
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Current Topics.

The Broad View.

The Leeds and Bradford Corporations are considering competitive foreign and British tenders for the supply of certain plant, and in each case the Continental offers are appreciably lower than those of British manufacturers, for obvious reasons. Nevertheless, the two committees responsible for coming to a decision on the subject are finding it difficult to allot the contracts. There should be no difficulty at all in such cases; that indecision exists is due to the narrow and parochial views of the local committees concerned. Here is an object lesson which should help those several Yorkshire councillors to make up their minds. Let them individually pay casual visits to the works' entrances of various large industrial engineering establishments in the immediate neighbourhood of Leeds or Bradford, at from 8 a.m. to, say, 10 a.m. any weekday, and exercise their faculties of observation.

They will find gangs of men and youths, as well as a sprinkling of women and girls, busily engaged holding up the neighbouring walls, what time they gaze disconsolately at notices intimating "No Vacancies." These unfortunate people are the local representatives of the vast army of unemployed. What is more, they represent, in the main, recipients of the dole, to which you, dear reader, and I and those Yorkshire councillors are all contributing in the shape of Imperial taxation. It means in plain fact that, in addition to working for our own benefit, and to keep the home fires burning, we are also putting in many hard days' work to help maintain that vast body of unfortunate beings for whom no occupation is for the time being available.

Now let us hark back for a moment to those competitive tenders which, I understand, in one case show a difference of as much as £10,000 between the British and Continental figures. The first duty of the councillors charged with arriving at a decision is to their local ratepayers—who are also, incidentally, taxpayers—whose property and money are involved. From a parochial standpoint the work should undoubtedly go to the lowest tenderer, inasmuch as it represents an apparent saving of, say, £10,000.

As a result, the capital expenditure on plant will be less, charges on that plant correspondingly reduced, and, in theory, electricity produced by means of it can be sold more cheaply, or, alternatively, the supply committee concerned will be able to show a surplus on the year's trading as a result of purchasing cheaper plant.

That is the theoretical reasoning of the individual who is seeking a decision on this momentous question. But there is another, essentially practical and commonsense side of the question. Let the contract to a Continental firm, and, all other things being equal, there is no diminution in local unemployment. Local taxpayers are still committed to huge payments in unproductive doles, and that £10,000, together with other like amounts, continues to be dissipated in the few weeks which intervene before the contract is due for execution. It cannot be too strongly or too frequently impressed upon those who have the spending of public money that every contract placed abroad, however apparently insignificant, helps to increase the already pressing problem of unemployment at home, and serves to perpetuate the vicious dole system which is responsible for a large proportion of our existing burden of taxation.

If Leeds and Bradford councillors seek a lead in solving this problem of municipal economics, let them turn to the example of Sheffield, where, although no definite policy has been laid down, there is nevertheless a strong prejudice against the placing of civic contracts outside this country. Some nine to ten months ago a turbo-generator was offered to the Sheffield Electricity Committee from Amsterdam. It was identical with a set then in use at the local power station. The offer represented an immediate saving of some £20,000 compared with the lowest British tender for equivalent plant. There was thus a strong inducement to purchase. So strong, however, was the opposition to the proposal, which appeared on the official minutes, that it was withdrawn when actually before the council, without discussion. The Committee have since placed an order for a similar set with a leading British firm, and on the definite condition that as much of the work as possible shall be done in Sheffield itself.

Placing important contracts abroad on the strength of a few thousands of pounds difference in the competing tenders is simply robbing Peter to pay Paul. It is far better to spend an additional few thousands of pounds in relieving unemployment, and providing productive work for our own population, than spend still larger sums in encouraging idleness, and snatch a purely imaginary saving over the British tender. Unless Parliament intervenes with a distinct embargo, or a heavy duty on imported wireless apparatus, we are going to experience precisely the same anomalous state of affairs, although on a smaller scale, in connection with the trade in broadcasting apparatus. If the advisory committee's recommendations go through as they stand, the majority of listeners-in will be enjoying their concerts, etc., this winter with the aid of German and other Continental apparatus of all descriptions.

It is unfortunately true that the factoring of cheap imported Continental apparatus is a far more profitable game to the people who are handling this branch of the industry (sic) than making a moderate but legitimate profit on the distribution and sale of British manufactured goods. As a result, the importer's vote is an influential one, and British manufacturers interested in the protection of their own industry will find it a stiff proposition to oust the parasites who batten on heavy profit margins from the sale of cheap Continental goods which they do not even handle. The public, who

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are purely interested in getting the best value for their money, are unfortunately apathetic concerning the origin of the apparatus they buy for the purpose of listening-in, and it is quite on the cards that the headphones some of these licensees will wear during the coming winter evenings were fashioned by the same pair of hands that sniped the wearer along the front line prior to 1918.

British makers of wireless apparatus cannot possibly compete on equal lines. Moreover, the present free import of foreign apparatus is having a very bad effect on British manufacture. Only yesterday I had the opportunity of closely inspecting and comparing the relative merits of three wireless headphones. Two were of German origin, priced at half the average figure for British 'phones. Although typically German in design, assembly, and finish, they were quite serviceable articles, and would sell readily on sight, to the average purchaser of wireless gear. The third was a competitive British model, which had just been turned out by one of the best-known firms in the trade, evidently at a rock-bottom cost, in an endeavour to beat the foreigner at his own game. The result was disastrous. Even externally I found it difficult to reconcile the design and finish with previous goods bearing this firm's name, but when the ear-caps had been removed, exposing the interior and workmanship, I was aghast. The workmanship belied the name; the 'phones might have been made by any amateur mechanic in an ill-equipped workshop. Pole pieces were imperfectly shaped, coil cheek cracked, and cross connections made with bare wire in imminent danger of touching the bare aluminium case. I rubbed my eyes, and looked again at the name of the maker. It was too true—and that headphone was priced at exactly twice the figure at which it is possible to buy single sets of the two German models!

ELEKTRON.

ELECTRICAL ENGINEERING—FINAL GRADE

SOLUTIONS TO 1923 EXAMINATION QUESTIONS OF THE CITY AND GUILDS INSTITUTE.

BY EDWARD HUGHES, B.Sc. (Eng.) A.M.I.E.E.

(*Continued from page 465.*)

Q. 6.—Show how to arrange two windings on the rotor of a 3-phase induction motor to provide automatically large torque at starting and low rotor copper loss when running.

How would you calculate the starting torque of such a motor?

A. 6.—One method whereby a 3-phase induction motor can be arranged automatically to provide a large starting torque and high-running efficiency, is to construct the rotor with two windings, one over the other. The outer winding is made of high resistance material and is of the squirrel-cage type, whilst the inner winding is of the wound type, the three ends of which are short-circuited by a centrifugal switch which closes when the speed attains a pre-arranged value. During the starting period this winding is on open-circuit, the motor being started by simply closing the stator switch. The stator starting current and the corresponding torque are governed by the high-resistance winding on the rotor; and in this way it is possible to obtain 2.5 times the full-load torque with about 3 × full-load current.

The starting torque of such a motor can be calculated from the circle diagram thus:—

Let OA in Fig. 9 be the no-load current and cos VOA

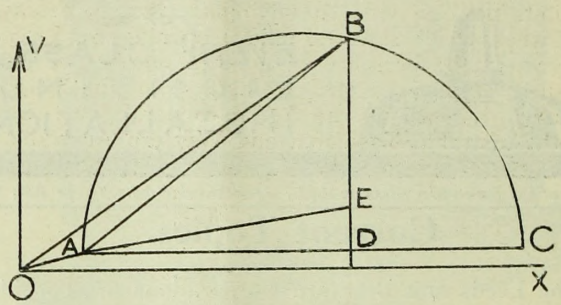


FIG. 9.

the corresponding P.F. Neither the no-load current nor the P.F. is affected appreciably by the low-resistance winding being short-circuited during this test.

Let OB be the short-circuit current for the rated voltage, the value of OB being proportioned from readings taken for lower stator voltages with the rotor oscillated slowly backwards and forwards. During this test, the low-resistance winding on the rotor is on open-circuit. Also, cos VOB is the P.F. on the short-circuit test.

Join AB and draw the semi-circle ABC. Draw BD perpendicular to OX, cutting AC at D.

Measure the resistance R between any two stator terminals; then if the winding be connected in star, resistance per phase is $\frac{R}{2}$, whilst if the winding be connected in mesh, resistance per phase is $\frac{3R}{2}$

From these values it can be easily proved that for both the star and the mesh connections, total I^2R loss in stator for a line current OB is $\frac{3}{2}R \times (OB)^2$.

If V be the rated line voltage, power component of OB to supply the stator I^2R loss

$$= \frac{\frac{3}{2}R \times (OB)^2}{1.73\ V}$$

and is represented by DE in above figure.

Consequently EB represents the power component of OB to supply the rotor I^2R loss; i.e., rotor I^2R loss at instant of starting $= 1.73V \times EB$.

If T be the corresponding torque in pounds-feet, and R be the synchronous speed in r.p.m., then if torque T had been exerted by rotor at synchronous speed, power supplied by rotor $= \frac{2\pi TR}{33{,}000} \times 746$ watts.

But on the short-circuit test, this power is expended as I^2R loss in the rotor resistance,

$$\text{hence } \frac{2\pi TR}{33{,}000} \times 746 = 1.73V \times EB,$$

so that T can be calculated.

(*To be continued.*)

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NOW OPEN AT OLYMPIA.

Preliminary announcements have given our readers an idea of the varied nature and imposing array of exhibits now on view at Olympia. It was Friday of last week which saw the official opening by Viscount Curzon in the presence of a large number of distinguished engineers and mainstays of the shipping industry, as well as the Agents-General for N.S.W., South Australia, Tasmania and Western Australia.

Praise is due to everyone concerned in getting such a display *in situ*, practically complete on the opening day, especially to the General Manager, Mr. F. W. Bridges, and the Organisers, F. W. Bridges and Sons, Ltd., who have also given us an official catalogue more replete with useful information, conveniently arranged, than we can remember on previous occasions. There is a classified index and visitors' guide to the principal exhibits, an index to exhibitors, plans, and lists of the official and other visits arranged, lectures and papers to be delivered, the films to be shown in the cinematograph theatre, etc. At the luncheon subsequent to the official opening, Mr. W. A. Appleton, C.B.E. (Secretary to the General Federation of Trade Unions), in proposing "Success to the Exhibition," made a happy speech on the "New Spirit in Industry." He admitted that brain and will power is necessary for commercial success, and that these qualities, being fundamental, cannot be produced, though they may be developed, by environment. He had a word to say against part of our educational system, maintaining that the first requirement was towards sustaining life, and, secondly, towards enjoying life. He concluded on the note that whereas in the past our main export was coal, in the future it would have to be brains and skill. The efficient must rule.

His remarks are very sound, and are welcomed by employers and so-called capitalists, and as soon as Mr. Appleton and other T.U. leaders can get their followers to adopt them and co-operate loyally with "capital," peace, progress, and increased comfort for all will result. Mr. Appleton is doing and will continue to do his very best in this direction. We only hope that he will obtain that support to which he is entitled, and that success will not long be delayed. Somehow we think things really are looking better.

Now a few words on the exhibits. These are all of great educational interest, and the public, particularly engineers, whether buyers or not, should not fail to visit Olympia before the Exhibition closes on the 22nd inst.

Limitations of space will probably prevent our saying much of the instructive and diversified shipping section, likewise the heavy engineering section. As regards electrical machinery and apparatus there is a very excellent display, and, naturally, electric welding is thoroughly represented. In addition to the main hall, the new hall and gallery contain exhibits. In the gallery, Skylux, Ltd., of 22, Great St. Andrew Street, Shaftesbury Avenue, W.C.2, show on stand No. 3 their patented portable rod, tube and conduit bending machine and self-locking shade ring remover—both very handy tools for the wireman. On stand No. 8c, the Concordia Electric Wire Co., Ltd. (155, Victoria Street, S.W.1), effectively display samples of bare and insulated wires and cables, high resistance wires and ribbons for motor starters, heaters, cookers and furnaces, etc. The "Electro-Automate" magneto lamps of the pocket, cycle, laryngoscope and egg-tester type, are shown by Theo and Co. (6, Hatton Garden, Liverpool), on stand No. 48.

In the New Hall, on stand No. 2, Crosbie and De Mowbray, Ltd. (25, Victoria Street, S.W.1), show generating sets from 120 watts upward, nickel-iron bell batteries, small pendant switches, Lithanode accumulators, in which the lead is cast round the active material, and the cell so made up that even a short circuit does not damage it, and electric fittings and accessories of all kinds especially suitable for yachts.

On stand No. 7, Ross, Courtenay and Co., Ltd. (Ashbrook Road, Upper Holloway, N.19), demonstrate their patent "Nonut" connection for sparking plugs, as well as their Ross Courtenay terminal for making sound connections without tools or solder.

The B.T.-H. Co., Ltd. (Crown House, Aldwych, W.C.2), have on stand No. 10 an excellent magneto exhibit, including separate and combined starting and lighting sets for motor yachts and vehicles.

In addition, examples of self-contained generating sets, welding plant, etc., may be seen.

MAIN HALL.

The following is a brief account of some of the exhibits :—

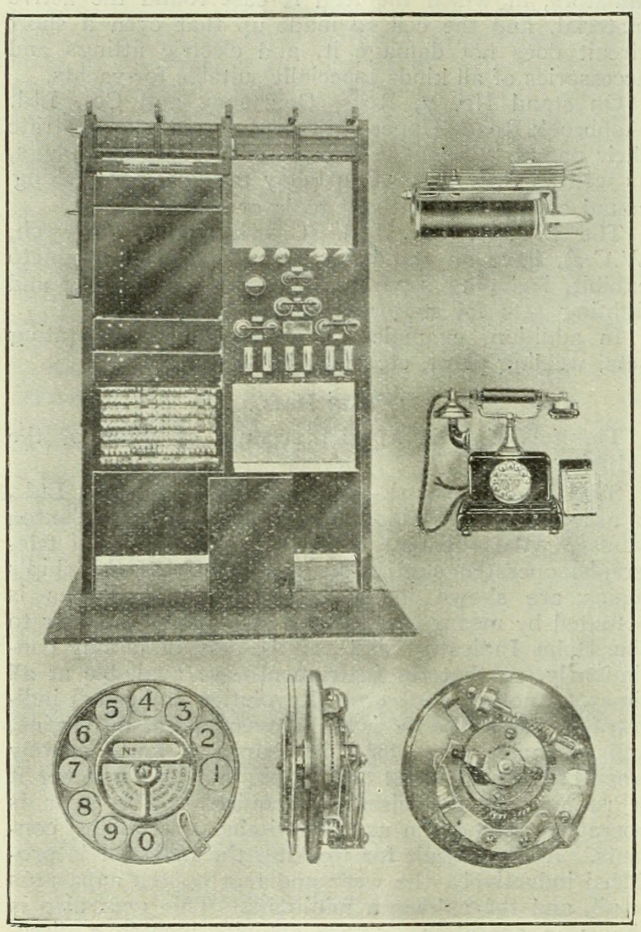
Stand No. 8 (row 1).—Siemens Bros. and Co., Ltd., in association with Elliott Bros. (London), Ltd. (Caxton House, Westminster, S.W.1). Engine-room telegraphs operated electrically independent of the ship's mains are shown in operation. The apparatus is actuated by means of a battery in a similar manner to the Helm Indicator, and can be left in circuit continuously, so that the instruments are available at all times. Another apparatus (Revolution Indicator) indicates on the bridge the actual movements of the engine, and so enables the officer in charge to know exactly when the engine starts and stops, and also whether it is running in the direction required. The gear is operated without the use of switches or rubbing contacts. As the circuit for working the indicator is produced inductively, the wear and tear on the apparatus is nil, and the upkeep a minimum. This gear also is shown in operation. Other exhibits include a directional revolution indicator, helm indicator (an apparatus which communicates the angle of the ship's rudder directly from the rudder to the bridge or wheelhouse independently of the ship's mains, being operated by its own battery of one cell. No switch is required, so that it remains permanently connected, and its indications are available at any instant. The battery supplied will last under these conditions about twelve months without renewal). There are also shown Forbes' Log and Look-out Indicator, etc., and loud-speaking telephones for providing communication between the bridge to the various parts of the ship, including the engine-room. The system possesses the unique feature that all the current necessary for operation is provided by batteries, and this current is so small that the battery will last for at least twelve months. Moreover, as an "Inert" cell is used, a spare battery can be carried on the vessel as a stand-by. The instruments exhibited include a telephone for the bridge, with a

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three-line selector switch, which enables connections to be made to the poop, forecastle, and engine-room.

Other exhibits include intercommunication telephones, ordinary telephones, wireless telegraph sets, electric distance thermometers, pyrometers for internal combustion engines, etc., suspended and pivoted coil indicators of various kinds, switchboards and accessories for pyrometers, batteries, Zed fuses, M.F. vacuum and gasfilled lamps, etc.—A most fascinating and instructive display.

The Relay Automatic Telephone Co., Ltd. (Marconi House, Strand, W.C.2), have on stand No. 20, Row C



A STANDARD 50-LINE "RELAY" INSTALLATION ILLUSTRATING THE SWITCHBOARD, A SINGLE "RELAY" AND THE STANDARD BOX-TYPE INSTRUMENT, TOGETHER WITH VARIOUS VIEWS OF THE OPERATING DIAL.

a complete private automatic telephone exchange. This exchange comprises the automatic switchboard, power board, two sets 24 volt batteries, and telephone instruments, all connected up for use. The switchboard consists of an iron frame into which the relay groups are fitted; these groups can be increased as required from time to time without putting the service out of action. The relay takes the place of the human operator, and, by a series of electrical circuits actuated through the dial on the telephone instrument, the caller becomes his own operator, and can automatically get into touch with any connection required within four seconds. Instruments of the well-known Post Office pattern are exhibited with a dial attachment, also a convenient form of box-type instrument, with combination hand telephone, which is recommended for both desk and wall use. A specially designed type of instrument for use aboard ship is also shown. An important feature that will be observed with regard to the wiring system is that two wires only are necessary from each telephone to the switchboard, and that the caller can connect himself to any of the other telephones served by the switchboard. We are informed that the company can arrange for existing branch exchanges to be replaced on a rental basis by the "Relay" automatic combined system, which gives a four-second automatic inter-departmental service, combined with public exchange facilities, and an attachment is exhibited showing how the private branch exchange operates in conjunction with the public service.

Stand No. 12, row H.—Automatic and Electric Furnaces, Ltd. (173/5, Farringdon Road, E.C.1.). Among the many furnaces to be inspected in operation here is the new design with element built on the unit principle with interlocking firebricks, in the face of which are recessed longitudinal grooves, through which are laid the heating elements, running the continuous length of the furnace. A full illustrated description of all details appeared in ELECTRICITY for July 27 last. Another feature of this exhibit is the Wild-Barfield furnace for hardening high-speed steel. It consists of a horizontal heating chamber, 9 in. by 5 in. by 3 in. clear, inserted in the roof being two bars of recrystallised carborundum. Through these the heating current passes. The connections are novel and simple, so that any hardener can replace the bars by new ones very quickly when necessary. There are also to be seen the W.-B. automatic hardening furnaces, horizontal type, air tempering muffles, laboratory muffles, pyrometers, accessories, etc. Also an electrically-heated furnace for soldering irons. Three irons should be in use—two being heated and one on the job. The furnace has a slight tilting motion which breaks the heating circuit on removal of the last iron, and remakes it when the iron is again inserted. As this automatic switching arrangement is effective there should be a good market for the device, for which agents are wanted. All furnaces make an excellent load, at "off-peak" times if desired, for the supply authority, and it is not surprising that the merits of W.-B. furnaces are being well appreciated.

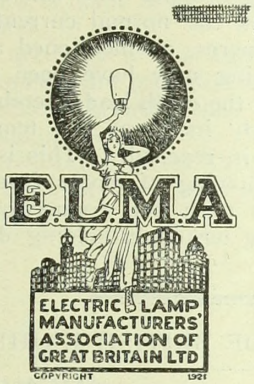
Stand No. 13, row E.—Scholey Construction Co., Ltd. (56, Victoria Street, S.W.1). The specialities here on view are R.W.B. welding machines and welding processes, dynamotors, "Seco" flux-covered electrodes, etc., also Daysohms low-tension A.C. arc welder. This machine is made in two types, each consisting essentially of a transformer and choke coil (adjustable) so that the necessary 65 volts giving any current for the weld can be obtained from the ordinary supply. The standard machines have a capacity of 25/150 and 25/80 amps. (normal). The machine is shown in operation and should be inspected, as should the excellent flux-covered eletrodes.

(To be continued.)

Japan.—The Report on the Commercial, etc., Situation in Japan has just been issued by the D.O.T., and may be obtained from H.M. Stationery Office (or ELECTRICITY Office), price 2s. 2d net post free. Electrical firms who are feeling the pinch of competition in electrical supplies manufactured in Japan should study this report carefully.

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Electric Lamp Prices again reduced



The Electric Lamp Manufacturers' Association of Great Britain Ltd.

announces the following

PRICE REDUCTIONS

Standard GASFILLED Lamps

Standard Voltages	Watts	Old Prices	New Prices
		s. d.	s. d.
100–130	30 *and* 40	3 0	2 6
200–260	40	3 6	3 0
100–130	60	3 6	3 0
200–260	60	4 0	3 0
100–130 *and* 200–260	75	5 0	4 0
	100	6 0	5 0
	150	8 6	7 0
	200	10 6	9 0
	300	13 6	12 0
	500	17 0	15 0
	1,000	21 0	20 0
100–130	1,500	30 0	27 6
200–260	1,500	27 6	27 6

Association Makes

British Thomson-Houston Co., Ltd.	MAZDA
Cryselco, Ltd.	CRYSELCO
Edison Swan Electric Co., Ltd	ROYAL "EDISWAN"
Foster Engineering Co., Ltd.	FOSTER
General Electric Co., Ltd.	OSRAM
Metropolitan-Vickers Electric Co., Ltd.	COSMOS
Pope's Electric Lamp Co., Ltd.	ELASTA
Siemens and English Electric Lamp Co. Ltd.	SIEMENS
Stearn Electric Lamp Co., Ltd.	STEARN
"Z" Electric Lamp and Supplies Co., Ltd.	"Z"

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Questions and Answers by Practical Men.

RULES.

QUESTIONS: *We invite our readers to send us questions, preferably on technical problems that have arisen in actual practice. Questions which we consider of sufficient interest to our readers will either be replied to under "Answers to Correspondents" or replies will be invited from our readers. One shilling will be paid for the question which we select for competitive replies in this column.*

ANSWERS: *A fee of 10s. will be paid for the answer which we consider shows the greatest merit, and 5s. for the one we select as second best. In judging the replies, importance will be attached to clearness and conciseness, as well as accuracy. The Editor reserves the right to make no award, or to accept only one reply, if, in his opinion, the answers received do not possess sufficient merit. Competitors desiring the return of their manuscripts, if unaccepted, should enclose stamped addressed envelope.*

Write on one side of the paper only, and if diagrams are sent, draw them on a separate sheet of paper attached to the manuscript. Competitors may adopt a "nom de plume," but, both in the case of questions and answers, the competitor's real name and address must be sent with the manuscript as a guarantee of good faith. No correspondence will be entered into with regard to successful replies. The Editor's decision is final.

Commencing with Question No. 101, a Diploma of Merit will be awarded to the six competitors who win the first or second prize the most times during the next twelve months.

The words "Questions and Answers" or "Q" and "A" should be placed at the top left-hand corner of all letters intended for this column.

QUESTION NO. 167.

I have a large bell in my works used to signal the "commence work" and "cease work" to my employees. At present it is operated by hand. Can I electrify this so that it will work if I press a button? If so, I would appreciate the details.—"CASHIER."

QUESTION NO. 168.

I wish to convert a 220 volt D.C. motor to one of 100 volts. The machine is 4-pole, wave wound, 10 b.h.p., 750 r.p.m. Can you give me the full details to enable me to carry this conversion out?—"WINDER."

(*Replies to Questions Nos. 167 and 168 must be received not later than September 29, 1923.*)

Answers to Questions.

QUESTION NO. 161.

The second prize (5s.) has been awarded to "F. P. S." for the following reply:—

The rules for earthing are the reverse of "hard and fast," as they are generally left to read "the installation shall be efficiently earthed." The word "efficiently" naturally gives rise to a diversity of opinions, and much difference between the contractor and the inspector.

If, however, the fact is always borne in mind that the earth is to act as a safety valve to the system, and that it is not to fail before the fuses go, or the cables burn out, there can be little room for doubt. By the earth is here meant not only the earthing cable, but also the earthing clips and the connections at each end of the cable. Should one of the clips be of the 5-ampere type there is little to be gained by putting in a cable to carry, say, 20 amperes. The carrying capacity of the earth must be taken to be that of its smallest part, on the principle that the strength of a chain lies in its weakest link. A connection to a water pipe other than the main supply may, therefore, render the whole earth useless, as may a wire wound round a pipe and unsoldered. In the case of machines where heavy earths are necessary, great caution must be used to see that the carrying capacity of the pipe is sufficient for the current that may be required to pass, and earths should never be made to gas pipes, owing to the joints being red leaded and the inflammable nature of the contents.

Taking now the case of the 10 b.h.p. 440 volt D.C. machine, and assuming that it will absorb 1,000 watts per h.p., we have an input of 10,000 watts, which, at 440 volts, corresponds to 23 amperes. It will, therefore, be necessary to fuse for 25 amperes, this being the nearest size wire obtainable. Therefore the earthing wire should be sufficiently large to carry this current without overheating. A 7/.036 (7/20) cable will carry 24 amperes according to the rules of the I.E.E., and I should recommend this size, although many contractors would adopt a smaller size. In some cases the mains cables may be larger than the earthing cable, as the question of voltage drop governs in some measure the size of the former.

The fusing of the $\frac{1}{8}$ in. copper wire is quite incredible, as it would require over 500 amperes to fuse such a conductor. Perhaps this is a mistake for 1/18 copper wire, but even then it shows a bad fusing of the circuits, for a 1/18 s.w.g. copper wire will only fuse at 108 amperes, whereas the normal current of the motor is fixed at 23 amperes, as mentioned above.

The cause of the fusing may have been a faulty connection somewhere in the earth lead, thereby generating heat, which slowly increases the temperature until the melting point is reached. This is a very common cause of the blowing of motor fuses, many of the faults being due to a bad connection at the spring contacts, or dirty terminals holding down the fuse wire.—"F. P. S."

THE ASSOCIATION OF BRITISH EXHIBITORS.

This association is now in process of formation, and a strong and influential provisional executive committee has been apointed. The objects are to protect exhibitors' interests in every way. Among the matters which will be dealt with are the securing of fair and advantageous rents for space, the redress of grievances relating to high prices for, and monopolies in stand fitting, etc. Then there are the questions of charges for power and lighting, of facilities for exhibitors, of restraining the use of exhibition space for cheap-jacks, side-shows and other stands which tend to defeat the object of an exhibition and lower its tone. The all-important question of publicity will receive careful consideration, together with many other points which affect exhibitors.

Our readers will be interested to learn that the electrical industry is worthily represented on the committee by the General Electric Co., Ltd. A special committee meeting was held yesterday.

Full details, with an application form for membership, can be obtained from the Secretary, the Association of British Exhibitors, 69, Victoria Street, S.W.1.

Dry Batteries Wanted.—The Post and Telegraph Dept. at Wellington, N.Z., invite tenders for 30,000 dry telephone cells. Specification, etc., at the D.O.T. (Room 52), 35, Old Queen Street, Westminster, S.W.1.

E.D.A. Publicity.—We have received from our worthy friends of Savoy House particulars of their "Late Lighting" campaign for the coming autumn, together with a list of the trade journals in which the advertisements will appear. Last year's effort was extremely successful, and we hope that similar good fortune will attend the present campaign. Contractors should make a point of getting these particulars from the E.D.A. in order to assist them in obtaining contracts for installation work of the kind suggested by the advertisements.

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THERMO-COUPLE POTENTIOMETER.

This apparatus, which has recently been placed on the market by Messrs. Siemens of Woolwich, is a simple form of potentiometer, specially designed for measuring the electro-motive force of thermo-couples. It has the following advantages :—

1. It is substantially made and carefully calibrated. There is very little to get out of order.
2. There is no mirror galvanometer, and therefore no lamp and light spot. A darkened room is not required. All readings can be taken in broad daylight.
3. It can be easily and rapidly adjusted, and is very easily read.
4. It has 5 ranges, and the change from one to the other is made by a simple movement of a lever switch.
5. The accuracy of the apparatus is high, and the ammeter and indicator may be easily and rapidly checked against each other and against a standard cell.
6. The resistance of the thermo-couple and its leads do not affect the results when the " Null method " is used.

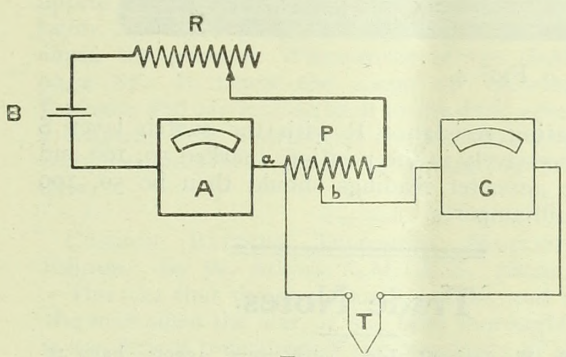


FIG. 1.

The principle of the apparatus is illustrated in Fig. 1. A battery B (*e.g.*, a 2-volt accumulator) supplies a small current (0.15 amp. max.) to the circuit B.A.P.R. R is a regulating resistance (of 0 to 100 ohms), A is a standard moving-coil ammeter (range 0–150 milliamperes), and P is an accurately adjusted resistance.

If the resistance of P between the points *a* and *b* is 0.1 ohm, and the current through the circuit B.A.P.R. is adjusted by means of the regulating resistance to, say, 100 milliamperes, the P.D. across *a*–*b* will be $100 \times 0.1 = 10$ millivolts, and proportionately greater or less as the current is varied.

The thermo-couple T, whose E.M.F. is to be measured, is connected across *a*–*b* in series with a suspended coil indicator G, which has a centre zero. If R is adjusted until G shows no deflection, the E.M.F. of the thermo-couple T must be equal to the P.D. across *a*–*b*, which may be read from the ammeter A. For example, if the ammeter reads 76.8 milliamperes the E.M.F. of T will be 7.68 millivolts.

By accurately subdividing the resistance P, and varying the potential point *b*, various ranges which are convenient multiples or sub-multiples of the ammeter scale can be obtained. For example, the range of the ammeter (which is 150 milliamperes) may be made to correspond to 7.5, 15, 30, 60 or 75 millivolts. Further, by choosing suitable values for P and by substituting a Weston Normal Cell in place of the thermo-couple T, the readings of the standard ammeter A can be checked against the standard cell.

In the method described above, the indicator G is simply used to indicate absence of current in the thermo-couple circuit, in which case the E.M.F. of the thermo-couple is exactly balanced by that across *a*–*b*. This is called the " Null method."

The indicator G is, however, calibrated 0 to 5 millivolts on either side of the centre zero, and in many cases it will be found convenient to set the ammeter reading to a fixed value and to read the " out of balance E.M.F." on the indicator. This is called the " Deflection method." For example, if the ammeter reads 100 milliamperes, corresponding to 10 millivolts across *a*–*b*, and if, instead of varying its reading (by adjusting the

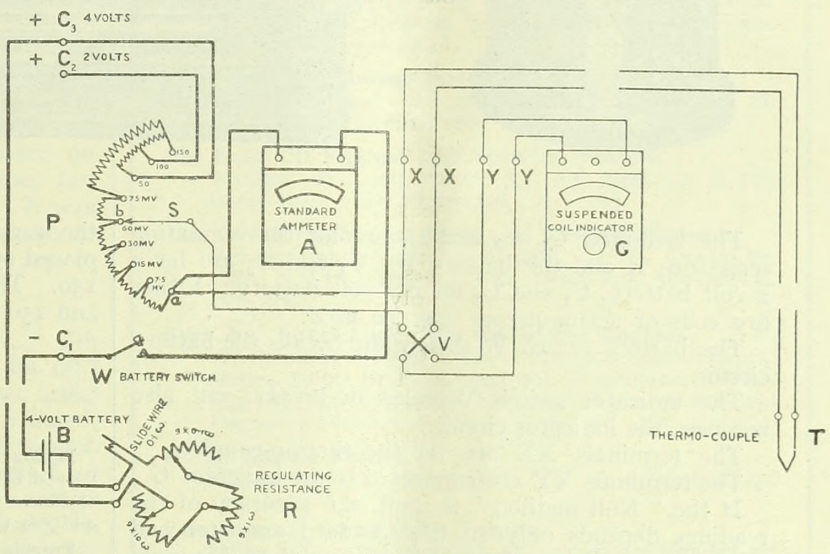


FIG. 2.—DIAGRAM OF CONNECTIONS.

resistance R) until the indicator G shows no deflection, the deflection of G is read and is, say, +1.2 millivolts, then the E.M.F. of the thermo-couple will be $10 + 1.2 = 11.2$ millivolts.

The regulating resistance R consists of three switch dials of 0 to 90 ohms, 0 to 9 ohms, and 0 to 0.9 ohm respectively, and a sliding resistance of 0 to 0.1 ohm.

The ammeter A is one of our standard moving-coil instruments, with a range of 150 milliamperes. It is fitted with an anti-parallax mirror, and each division corresponds to 1 milliampere. Length of scale, 140 mm. Resistance, 1 ohm. The ammeter is fitted with a compensating device which makes its readings independent of temperature variations.

The indicator G is of the suspended-coil type, and is very sensitive. It has a centre zero, and a range of 10 millivolts, *i.e.*, 5 millivolts on either side of zero. It is fitted with an anti-parallax mirror and each scale

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division equals 0.1 millivolt. The total resistance is about 400 ohms, of which approximately 250 ohms is a series resistance. The instrument is fitted with three terminals so that, if desired, the series resistance may be cut out of circuit, thus increasing its sensitiveness about $2\frac{1}{2}$ times.

The lever switch S varies the position of the potential point *b* on the resistance P. It is substantially made, with copper contact blocks and laminated copper brush contacts. It has eight positions in all. The first five positions afford the following ranges for the measurement of the thermo electro-motive forces : 7.5, 15, 30, 60 and 75 millivolts ; the last three positions enable the standard ammeter to be checked against a Weston Normal Cell at points corresponding to 50, 100 and 150 milliamperes on the ammeter scale. The resistance P is of carefully aged manganin, and is accurately adjusted and subdivided.

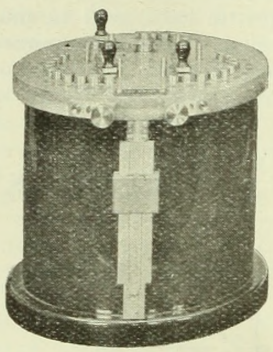


FIG. 3.

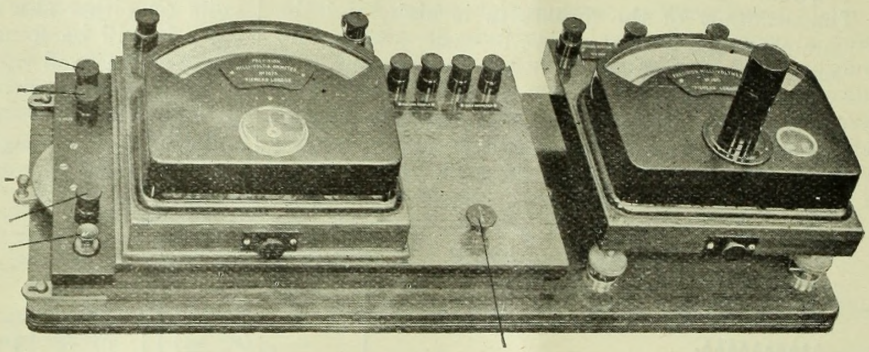


FIG. 4.

The terminals C_1, C_2 and C_3 are for the regulating resistance R and the battery B. C_1 and C_2 are for a 2-volt battery, C_1 and C_3 for a 4-volt battery. Either dry cells or accumulators may be used.

The battery switch W makes and breaks the battery circuit.

The indicator switch V makes or breaks, and also reverses, the indicator circuit.

The terminals XX are for the thermo-couple.

The terminals YY are connected to the indicator G.

If the " Null method " is used, the accuracy of the readings depends only on the standard ammeter and the resistance P. If the " Deflection method " is used, and readings are taken on the indicator, the accuracy of the readings will depend to some extent on the indicator. The latter, however, is carefully calibrated, and although, owing to its weaker control and greater sensitiveness, it is less accurate than the standard ammeter, nevertheless any slight error in it will not affect the readings to any appreciable extent.

For example, if in the case previously mentioned—where the ammeter reading was 100 milliamperes (corresponding to 10 millivolts), and the indicator reading 1.2 millivolts—the error in the indicator reading should for any reason be $\frac{1}{2}$ per cent., then the error in the total reading will only be 0.05 per cent.

Further, if the " Null method " is used, the resistance of the thermo-couple and its connecting leads do not affect the result in any way. If, however, the " Deflection method " is used, they will affect the readings, but to a very small extent. For example, supposing the resistance of the thermo-couple and leads to be 4 ohms, and that of the indicator to be 400 ohms, the error due to this cause will be 1 per cent. on the indicator reading, but only 0.1 per cent. on the total reading of 11.2 millivolts.

Results obtained by the " Deflection method " may always be easily and quickly checked by the " Null method." Also the readings of the indicator may be very easily checked against the standard ammeter by short-circuiting the thermo-couple terminals XX. By varying the regulating resistance R, readings may be taken at any part of the indicator scale, and these readings should then agree with those of the ammeter read according to the scale indicated by the position of the lever switch S. Further, the readings of the standard ammeter itself can be checked against a Weston Normal Cell if one is available. The standard cell should be connected in place of the thermo-couple, and the indicator pointer brought to zero by adjusting the regulating resistance R with the switch lever S placed successively in the positions marked 50, 100 and 150. The ammeter readings should then be 50, 100 and 150 milliamperes.

Trade Notes.

Messrs. R. H. Jackson, Ltd., advertisers' agents, have removed to more commodious premises at 1, Princess Street, Manchester. Their telephone number (Central 1041) and telegraphic address ("Adroit, Manchester") remain unaltered.

Francis Polden and Co., Ltd., have transferred their showrooms from 17, Wells Street, W., to more extensive premises adjoining their head offices at 56, Cannon Street, E.C.4 (telephone City 5538-9). In addition to the general availability of a technical staff conversant with the apparatus displayed, we understand that special demonstrations are being arranged.

A revised price list of electric lamps has just been issued by the **Sun Company**, of 118, Charing Cross Road, London, W.C.2. It applies to the leading types now on the market.

Fuller's United Electric Works, Ltd., of Chadwell Heath, Essex, have opened a London depôt at 58, High Street, W.C.2 (close to Tottenham Court Road Tube Station). Here adequate stocks of "Sparta" and wireless batteries, accumulators, dry cells and wireless accessories, cables and wire are maintained. Facilities for battery repair and charging are provided. 'Phone Gerrard 5070.

Obituary.—We regret to announce the death of Mrs. Ayrton, widow of the later Professor Ayrton, and the only lady member of the Institution of Electrical Engineers. She was well known in our profession in connection with her researches in the "Hissing of the Electric Arc" and other papers on similar subjects.

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Reviews of Books, &c.

[*Books noticed in this column will be sent from* ELECTRICITY *Office to any part of the world, for the published price, plus five per cent. for postage (minimum 2d.), and orders will be appreciated.*]

ELECTRIC LIGHT FITTING. By J. W. Urquhart. Cr. 8vo, cloth, 164 pp., 45 illustrations. (Lockwood, 5s. net.)—This book does not claim to be a new edition of the author's original work, under the same title, which was on the market in 1890, but to be a fresh book containing only that small portion of the original which may be considered up-to-date. In a sense it is practical enough, and the wireman who consults its pages will find that the teaching is sound and based on the I.E.E. rules, although the arrangement may appear somewhat crude. Evidently the author is a believer in the remarks made by Mr. Gill, the president of the I.E.E., at the E.C.A. dinner a short time back, to the effect that we might almost be accused of excessive care in our wiring work, and that the open wiring with insulators, which is so much in vogue on the Continent, did not necessarily lead to widespread fires. Mr. Urquhart states bluntly enough in the opening section of the chapter on cable-running systems that, in his opinion, a great deal of the present high cost of fitting up buildings is simply thrown away. In the writer's opinion the book needs more diagrams. They add much value to a work of this nature which is meant to appeal to the practical man, while he would most certainly like to know where any reader could now purchase the portable Wheatstone bridge illustrated on page 87. It bears the name of Woodhouse and Rawson, and carries one back to the dark ages. It was a beautiful little instrument, but the illustration should most certainly be replaced by something more up-to-date.

COMMON BATTERY TELEPHONY SIMPLIFIED. 4th Edition. By W. Atkins, A.M.I.E.E. (Benn. 8s. 6d.)—The fact that this is a fourth edition, and that being the first since the war, it has been thoroughly revised, is a sufficient indication of the popularity of the former issues, and testifies to the adoption of a method of treatment of his subject which appeals to the average student and telephone engineer. In most books on telephony, common battery systems are described with the aid of very complex and puzzling diagrams, usually reproductions of Post Office or wiring diagrams which necessarily include much irrelevant matter, and therefore render it difficult for the reader to follow a particular function to the exclusion of all others shown. Glancing through the pages of the work under review it is impossible to single out a diagram which can in any sense of the word be termed complex. Circuits have been reduced to the simplest possible form for their clearer understanding, whilst all diagrams are remarkably well drawn and clearly printed. Coupled with the concise and comprehensive treatment of the subject in the accompanying text the book well deserves the qualification implied in its title, for it most certainly simplifies the study of this particular system of manual telephony. The present edition is thoroughly up-to-date and we cordially recommend it to readers and students, who find the usual treatment of the subject in most text-books rather too advanced.

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ELECTRIC LIFT EQUIPMENT FOR MODERN BUILDINGS. By Ronald Grierson, A.M.I.E.E. Demy 8vo, cloth, 194 pp., 96 illustrations. (Chapman and Hall, 15s. net).—A good book on electric lifts, and dealing directly with British practice, has been long overdue in this country. Papers have been read on the subject before technical societies, and in due course published in their "Proceedings," as for instance the excellent paper read recently by Mr. Marryat before the N.A.S.E., but that is not the same thing. It is not possible to submit a paper which can be quite so comprehensive as a carefully prepared book, and in many instances the paper represents experience of an engineer who is intimately acquainted only with the particular make or system about which he writes, Also, most useful pamphlets have been issued from * the office of a contemporary, and † H.M. Stationery Office, but in neither case can it be said that they do more than give a superficial idea of a subject which has grown very rapidly during recent years, and is likely to develop to a still greater extent as new and up-to-date buildings are erected on ground hitherto occupied by offices and dwelling houses of the old-fashioned type. Mr. Grierson's book is, therefore, certain of a cordial welcome from all architects, electrical engineers and installation contractors who are in any way interested in the preparation of plans or estimates for the erection of electric lifts of the various types now on the market, and it will further appeal to the supervising electricians and workmen who are engaged on the actual work of erection, wiring and testing. The twenty-four chapters and appendices into which the book is divided take the reader through the subject very carefully, from estimating service requirements, the types of car which may be adopted, the car slings, guide rails, ropes, types of drive, engines, motors, control gear, down to the actual details of operation and maintenance. There is an interesting and well-illustrated chapter on the escalators which are now being adopted in busy railway stations, etc., together with a lot of useful information on the subject of specifications and the way in which they should be drafted. Finally, the author states that, in his opinion, from the point of view of public safety, the installation, operation and maintenance of lifts requires closer supervision than it has hitherto received. The book is a valuable addition to English technical literature, and we can recommend it most cordially.

* Electrician Primer, "Electric Lifts." 6d net.
† Technical Pamphlet, "Lifts." 6d. net

Large Motor-ships.—In the September issue of *The Motor Ship* are published details of the second largest oil-engined craft in the world, which has just been completed in Germany. This is a tanker with a carrying capacity of about 14,000 tons of liquid fuel, and is intended for the transport of oil from the United States to Germany. It is satisfactory to note, however, that far larger internal-combustion engined ships are now under construction in this country, including four passenger liners, varying from 17,000 to 20,000 tons displacement. There is also an interesting illustrated article on the employment of electricity in motor-vessels.

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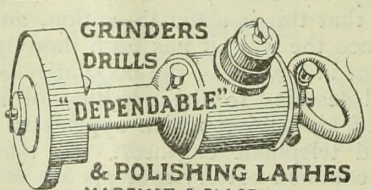
IMPROVED ELECTRIC FIRES.

A short time age we referred to the new design of elements used in Arora electric fires—an improvement on the early Arora elements, which were remarkably successfully as regards appearance, efficiency and life. We would now draw attention to the new type "Rosebery" fire (illustrated in our advertisement columns), as, in addition to the new element, the general design of the frame is particularly graceful. The two elongated "S"-shaped front linings are of cast polished aluminium, the remainder of the framework being of handsome castings and sheet metal—polished brass, antique copper, oxidised silver or rustless bright steel. Full particulars of this and other designs can be obtained on trade application to the Arora Co., of Loughborough.

Various Items.

The Blind.—The annual report of the National Institute for the Blind has just been issued, and shows the work which has been done by this Institute in this country. It is well worthy of support.

Siemens Lamp Family.—Siemens and English Electric Lamp Co., Ltd. (38-39, Upper Thames Street, E.C.4), have issued a series of excellently arranged and printed lamp catalogues, in which the prices now ruling are shown, together with illustrations and descriptions of the many types of Siemens lamps available. Catalogue No. 81 deals with M.F. vacuum type lamps, No. 82 with M.F. gasfilled type lamps, No. 83 with Siemens lamps for automobiles, hand-lamps, inspection lamps, etc. Each is a very useful publication. Gasfilled projector lamps for cinematograph projectors, optical lanterns, flood-lighting apparatus, etc., are treated in list No. 84/P, and carbon filament lamps in catalogue No. 85. In addition, there is list No. 88/F (4 pp.), with cover design, dealing with vacuum and gasfilled type lamps. Factors can have supplies overprinted on application, while bona fide electrical contractors or automobile engineers can have overprinted supplies of folders 86 and 87, both artistic and attractive productions.





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A POPULAR SCIENTIFIC WEEKLY JOURNAL
ELECTRICITY
A PRACTICAL TRADE JOURNAL

SEPTEMBER 14, 1923.

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HELPING THE RETAILER TO SELL MAZDA LAMPS.

B.T.-H. Advertising Plans for the Coming Lighting Season.

From advance information received it would appear that the "Mazda" Advertising Campaign for the 1923-24 lighting season is to be of a most comprehensive character, well calculated to help the retailer in his efforts to sell more electric lamps. Although some of this advertising is, of course, addressed directly to the public through the medium of newspapers, etc., in all cases the readers are enjoined to go to their local dealers for any lamps that they may require. All the various forms of advertisement described in this article are, therefore, of direct benefit to the retailers of Mazda lamps.

The campaign comprises: (1) Advertising in the general press; (2) the supply of advertising devices, such as signs, window displays and showcards to retailers for use in their own shops; (3) the supply of leaflets in quantity for distribution by retailers.

A "Daily Mail" Front Page.

Between now and the end of the year an interesting series of advertisements will appear in the more important papers in the United Kingdom. For example, to-day the front page of the *Daily Mail* bears the advertisement reproduced in Fig. 1.

It should be noted that the Mazda advertisements, of which this is one, are of the "interest" type, and they will doubtless pique the curiosity of the average newspaper reader who is always eager for scientific facts, so long as they are served up in a simple and palatable fashion.

Display Material for Dealers.

Among the attractive display material is the window display itself, of which the central figure is a life-sized cut-out of the "Mazda" Girl, see Fig. 2. The life-like figure is printed in natural colours, and is an excellent example of the lithographer's art. A coloured banner, printed on fabric and eyeletted for hanging, is also supplied for use in conjunction with the figure. It is intended that the dealer should use a number of Mazda lamp containers and wrappers to complete the

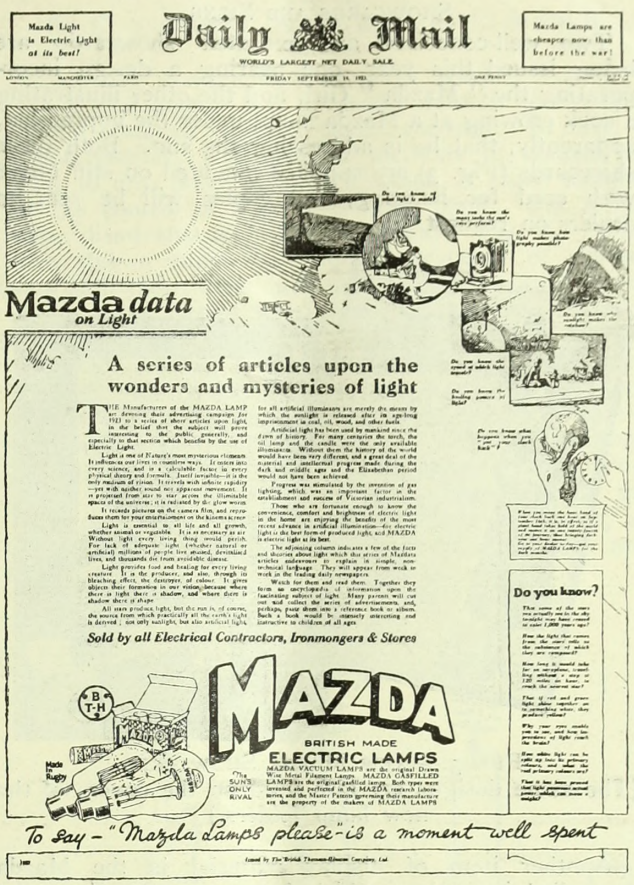


FIG. 1.—A GOOD FRONT PAGE.
(Facsimile in miniature of Mazda front page advertisement on September 14.)



FIG. 2.—MAZDA WINDOW DISPLAY.
(The figure of the "Mazda" girl is life-size and life-like.)

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display. There are only a limited number of these displays, and these will be sent to early applicants.

SHOWCARDS AND SIGNS.

Two well-conceived and executed showcards are being issued this year, one bearing a design incorporating the "Mazda" Girl, and the other illustrating a cock crowing at a Mazda lamp, under the impression, apparently, that he is addressing the sun. Both these showcards (Fig. 3) are supplied mounted on stiff board with cord for hanging, and copies will be sent to dealers on request.



FIG. 3.—NEW MAZDA SHOWCARDS.
(The same designs are also used on the covers of the new lamp folders.)

Another item of display material is the Mazda enamelled iron sign, which bears an attractive and striking design in four colours. The contour and brilliant effect mark it with originality. It is

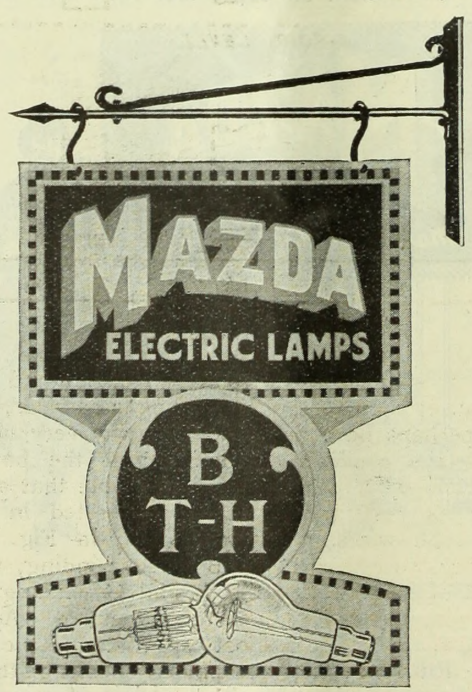


FIG. 4.—ENAMELLED IRON SIGN IN FOUR COLOURS.

undoubtedly the sign of a good lamp and of an enterprising contractor, and will soon be found all over the country.

AN IMPORTANT WEAPON.

Overprinted literature is an important weapon in the dealer's armoury, and the B.T.H. Co., Ltd., have this year produced leaflets, at least up to their high standard as regards printing, paper, cover design and arrangement. Folder L.279 contains up-to-date prices of all standard vacuum and gasfilled lamps. The cover bears the same design as on the "Mazda" Girl showcard. A new feature is the inclusion of an interesting series of thumb-nail illustrations indicating the size



FIG. 5.—HIGH LIGHTS OF HISTORY.
(Six-page inside opening of "Rulers of Britain" folder. Alongside each royal portrait is shown a typical lighting unit of the period.)

and type of Mazda lamps to use in the various rooms of private houses, and in the various kinds of fittings used for residental lighting. Folder L.279a differs from folder L.279, in that its cover bears the "Crowing Cock" design instead of the "Mazda" Girl design. Otherwise it is the same as L.279. Both are available for overprinting with contractors' names and addresses.

FOR STUDENTS OF HISTORY.

Another folder, No. L.280, in addition to giving up-to-date prices of all standard vacuum and gasfilled lamps, bears on the inside six-page opening a series of portraits of the rulers of Great Britain, from King Alfred to the present time. Alongside each portrait is illustrated a typical lighting unit of the period (Fig. 5). This folder is available in limited quantities for overprinting.

All these folders give particulars of the latest addition, the White Mazda lamp. This is a gasfilled

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lamp, in which the high intrinsic brilliancy is corrected in the lamp itself by means of a porcelain-like enamel sprayed upon the bulb. This enamel conceals the filament, and produces a uniform diffusion of light over the whole surface of the bulb.

A Broadcast Appeal.

Another important feature of the Mazda 1923-24 Advertising Campaign is the direct circularising of electric light users throughout the country. During the last few days a calendar mailing card has been mailed to over 500,000 electric light users. This card is attractively printed in colours. The calendar covers the six months of the lighting season, namely, October, November, December of 1923, and January, February and March of 1924. Undoubtedly a great many of these cards are kept by recipients and set up in a prominent position. In this way, a long-period advertisement is placed within the houses of a substanial proportion of the electric light users of the United Kingdom. It is, of course, difficult to assess the exact value or effect of this kind of advertising,

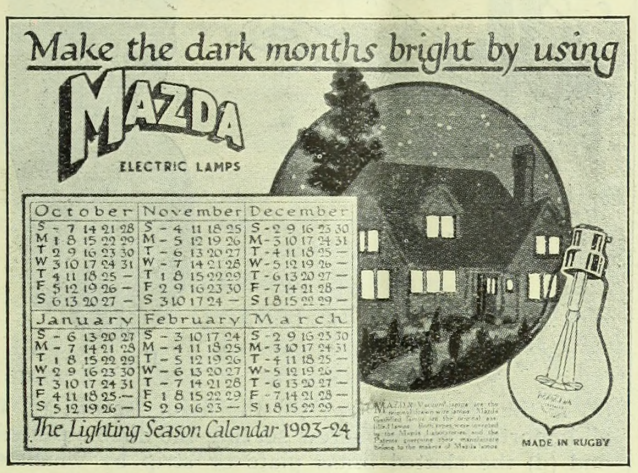


Fig. 6.—A Message to 500,000 Lamp Users.
(Copies of this card are being sent through the post to over half a million electric light users in the United Kingdom.)

but from previous experience it is known that a considerable impetus in sales always follows the issue of such a circular. It should be remarked that this increase in sales comes through the retailers, thus indicating that the people who receive the circulars go to their local dealers for supplies of Mazda lamps. They are, of course, asked to do this on the circulars themselves, and in any case the address of the B.T.-H. Co. is not printed on the cards, so that inquiries are bound to be made through local dealers.

This point is emphasised here because, if it indicates one thing more than another, it is that dealers should carry adequate stocks of all standard sizes of Mazda lamps in order to ensure that they will be able to deal with the inquiries resulting from this general circularising of the light-using public.

Electrical contractors who desire further information regarding Mazda advertising plans for the coming season should communicate with the British Thomson-Houston Co., Ltd., at Crown House, Aldwych, W.C.2, or at the nearest branch office.

THE LIMITATIONS OF RHEOSTATIC CONTROL OF ELECTRICAL MACHINERY IN MINES.

By C. Sylvester, A.M.I.E.E., A.M.I.Mech.E.

(*Concluded from page 468.*)

It is well known that extremely smooth acceleration can be obtained with the liquid rheostat. In fact, it is not possible, with present methods of control, to point to any other resistance which is more suitable for the control of a main winding plant. But it has many disadvantages. Let us consider Fig. 3. This illustrates a tank with liquid resistance of caustic soda and water, such as is used to regulate the current to the rotor circuit when starting the motor. The same resistance is used, through a controller, to pass the direct current through the stator windings when braking. The connections in the controller are such that, although the three plates may be lowered in the solution together, the current will only pass through certain phase windings. The upper part of the illustration shows the plates above the liquid level, the lower part shows the plates lowered in the water, so that there should be no resistance between them and the contact blocks, 1, 2, and 3.

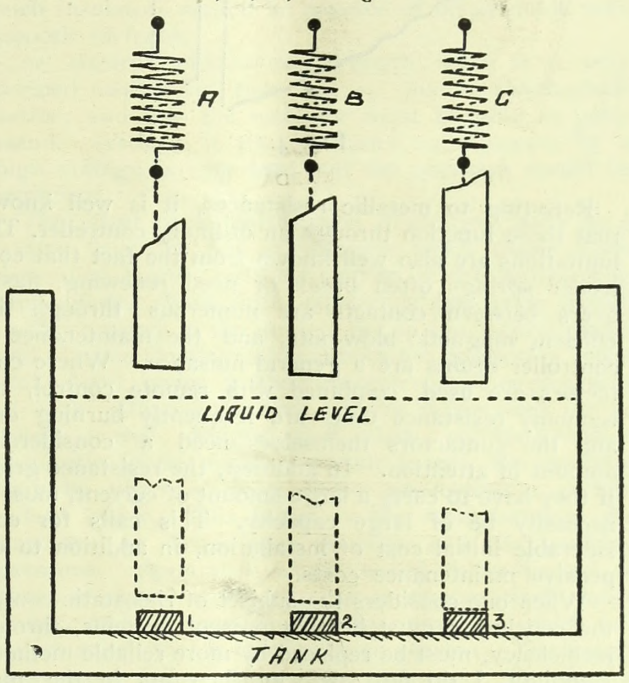


Fig. 3.

Anyone who has had experience with liquid controllers realises that, after a time, the plates wear, or *burn* would perhaps be a better word, away very unevenly, so that the conditions illustrated at the bottom of the sketch exist. That is, it is possible that a certain amount of resistance is always inserted in one or more phase windings. Consider B, in Fig. 1, if a resistance were inserted in B phase winding, then the amount of current through B and C windings would be uneven, and this is not to be desired. Again, in starting the motor it is most essential that the amount of current through all three phases should be the same, and this is not possible with plates such as are illustrated.

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The greatest argument against the use of liquid rheostats is, perhaps, the large number of breakdowns which occur through the action of the liquid. The liquid will creep and deposit a conductive film of matter over all insulators, etc. I have known this creeping to break down stiff mica bushes and washers, especially in damp places.

Fig 4 illustrates a method generally used to prevent uneven currents through phase windings due to defective plates. Here A is a gun-metal contact, which connects with a spring contact B, when the plate is completely lowered into the tank. This contact short circuits the resistance between the bottom of the plates and the contact blocks at the bottom of the tank, but even this does not reduce the evils of uneven currents at starting, when the bottoms of the plates must touch the liquid and gradually cut the resistance out.

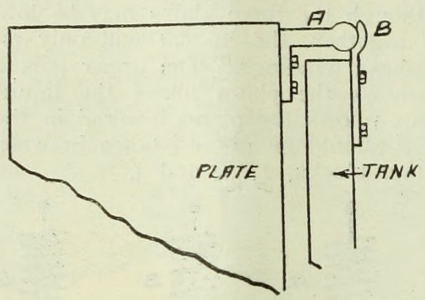


FIG. 4.

Referring to metallic resistances, it is well known that these function through an ordinary controller. The limitations are also well known from the fact that controller springs often break or need renewing, flash-overs between contacts are numerous through inefficient magnetic blow-outs, and the maintenance of controller drums are a general nuisance. Where contactors are used, combined with remote control, the economy resistance units are frequently burning out, and the contactors themselves need a considerable amount of attention. In addition, the resistance grids, if they have to carry a large amount of current, must of necessity be of large capacity. This calls for considerable initial cost of installation, in addition to expensive maintenance costs.

When one considers the subject of rheostatic control the conclusion must be that present systems, through inefficiency, must be replaced by more reliable methods. Candidly, I do not see why rheostats in the main circuits should be used at all. The most efficient method appears to be to regulate the source of supply. Since this is a direct-current supply, a field rheostat would be inserted in the field system of a direct-current generator and the *voltage* applied to the main winding motor could be regulated. Since the resistance of the phase windings are constant and the voltage of the generator can be vared, then the amount of current through the phase windings will be in proportion to the voltage of the generator. Again, a field-regulating rheostat can be so designed, at small cost, to regulate the current in fractions of an ampere. This would produce the smooth conditions of working so noticeable with the liquid rheostat. The matter is worthy of the close attention of designers if greater efficiency is to be attained.

THE "TANGENT" CONTACT PILLAR.

As more electric bells go out of commission through the contact breaker twisting on its axis than through any other cause, the new "Tangent" patent untwistable contact pillar, made and marketed by Gent and Co., Ltd., Faraday Works, Leicester, should receive a wide welcome. The screw which locks the contact screw in position after adjustment also locks the contact pillar itself in the adjusted position so as to prevent it effectively from turning on its axis or being forced out of position by the vibration of the bell, even if its axial or central fixing screw becomes loose—as such screws often do. Details of the pillar are shown in Fig. 1 and a complete bell in Fig. 2;

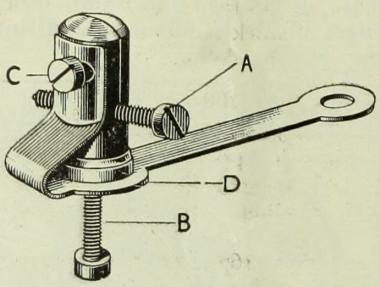


FIG. 1.

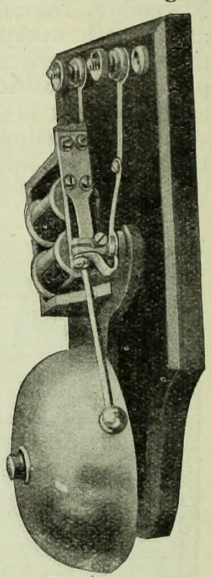


FIG. 2.

(a) is the contact screw, (b) the fixing screw, (c) the all-important locking screw serving the double purpose, and (d) the slotted brass plate or strip by which the "locking" result is obtained. The slot in this plate through which the screw (c) passes should be noted. As is usual, the strip also acts as a terminal.

"Tangent" patent contact pillars are inexpensive, and are sold separately so that they can be fitted to existing bells if desired.

Telephone Rates in Chicago.—New telephone rates for residence and business coin-box subscribers in Chicago, effective October 1, are fixed in order issued by the Illinois Commerce Commission August 16, making a drastic cut in these rates. Accompanying the order was a statement by Colonel Frank L. Smith, chairman of the Commission, estimating the annual saving to subscribers of these classes of service at $1,900,000. Mr. W. R. Abbott, president of the Illinois Bell Telephone Co., announced that the order will be resisted by an appeal to the courts.

E.D.A. Salesmanship Conferences.—Tickets for series of Conferences in the London area, season 1923-4, have been issued. The Conferences will take place in the St. Bride Foundation, Bride Lane, Fleet Street, E.C.4, at 7.30 p.m. on Fridays, September 21, October 19, November 16, December 14, January 18, February 15, March 21 and April 11. Particulars of the various meetings are given on the card. At the first Mr. J. W. Beauchamp will read opening papers on (1) "The Scope and Object of the E.D.A. Sales Conferences," and (2) "Some Notes on the Commercial Aspect of Electric Lighting." Mr. W. B. Woodhouse will occupy the chair.

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Questions and Answers by Practical Men.

RULES.

QUESTIONS : *We invite our readers to send us questions, preferably on technical problems that have arisen in actual practice. Questions which we consider of sufficient interest to our readers will either be replied to under "Answers to Correspondents" or replies will be invited from our readers. One shilling will be paid for the question which we select for competitive replies in this column.*

ANSWERS : *A fee of 10s. will be paid for the answer which we consider shows the greatest merit, and 5s. for the one we select as second best. In judging the replies, importance will be attached to clearness and conciseness, as well as accuracy. The Editor reserves the right to make no award, or to accept only one reply, if, in his opinion, the answers received do not possess sufficient merit. Competitors desiring the return of their manuscripts, if unaccepted, should enclose stamped addressed envelope.*

Write on one side of the paper only, and if diagrams are sent, draw them on a separate sheet of paper attached to the manuscript. Competitors may adopt a "nom de plume," but, both in the case of questions and answers, the competitor's real name and address must be sent with the manuscript as a guarantee of good faith. No correspondence will be entered into with regard to successful replies. The Editor's decision is final.

Commencing with Question No. 101, a Diploma of Merit will be awarded to the six competitors who win the first or second prize the most times during the next twelve months.

The words "Questions and Answers" or "Q" and "A" should be placed at the top left-hand corner of all letters intended for this column.

QUESTION NO. 167.

I have a large bell in my works used to signal the "commence work" and "cease work" to my employees. At present it is operated by hand. Can I electrify this so that it will work if I press a button? If so, I would appreciate the details.—"CASHIER."

QUESTION NO. 168.

I wish to convert a 220 volt D.C. motor to one of 100 volts. The machine is 4-pole, wave wound, 10 b.h.p., 750 r.p.m. Can you give me the full details to enable me to carry this conversion out?—"WINDER."

(*Replies to Questions Nos. 167 and 168 must be received not later than September 29, 1923.*)

Answers to Questions.

QUESTION NO. 162.

Can any reader give me details of the facts which govern the choice of high-tension insulators? I have heard talk of "Corona effect." What is this? Does it affect insulators used on voltages of over or under 6,600 volts?—"JOINTER."

REPLIES TO QUESTION NO. 162.

The First Prize (10s.) has been awarded to "L. R." for the following reply:—

The main requirements of high-tension insulators are that they shall be:

(1) Non-hygroscopic.
(2) Not readily altered by strong oxidising influences.
(3) Of good electrical resistance.
(4) Of comparatively high mechanical strength to withstand mechanical forces due to electrostatic stresses.
(5) Be capable of taking a high polish, or in other ways of receiving a smooth surface.
(6) In most cases be capable of being shaped into such forms as are necessary for preventing the flashing over of a discharge from one part of the insulator to another, and for prevention of a continuous moisture film.

The requirements of a high-tension insulator are intimately bound up with the corona effect.

Corona may be defined as the manifestation of the charging current which, when spreading over the insulator, first forms a glow, then steamers, and ultimately results in a definite and perhaps continuous discharge from one end of the insulator to the other.

The corona is the effect of condenser action. An insulator essentially is a condenser, and when the capacity of the insulator is large, the charging current also must be large. This charging current is the basis of the corona. Discharge of a high-tension insulator may take place partly through the body of the insulator, partly through the air, and partly over the surface of the insulator.

Many patented arrangements have been devised to restrict the discharge to the proper channels. Glow discharges follow the same direction as the electrostatic lines of force, and, if this direction coincides with the surface of the insulator, the glow spreads along that surface. The insulator should, therefore, be so shaped that the electrostatic lines of force are substantially at right angles to the insulator surface.

The discharge from a high-tension insulator may be accompanied by the production of ozone which, by nature of its highly oxidising effect, particularly in the nascent state, requires an insulating material for this purpose to be not readily oxidised. A strong discharge may mechanically tend to tear away the surface of the insulator, particularly if there exist any points from which the discharge can start, or a roughened surface comprising a series of points. For that reason such insulators should be capable of being made with smooth surfaces.

As regards mechanical strength there is a very decided mechanical stress set up, due to electrostatic action, and this the insulator must be able to withstand. Without it the resistance to puncture by a high voltage is very low, and the insulator would be inefficient.

The effect of a high-tension discharge, such as a corona, may be felt at voltages much under 6,000 depending largely on the condition of the surrounding atmosphere. Very little experience has been gained in this country in the matter, but in the United States and in some Continental countries the position is better understood, owing to their more frequent employment of high-voltage apparatus. There is no need for so many varied designs and sizes of high-tension apparatus as one finds commonly listed. An insulator may be regarded as a device possessing a certain safety factor. This factor is the ratio between the flash-over or breakdown pressure and the working pressure. Apparatus which would be subjected to great electrical stress requires a comparatively large factor, and the same applies to apparatus which has to be relied on for continuity of service. The safety factor may fall as the voltage increases. This is due to the fact that at low pressures excess voltages are mainly due to the current, as in short circuits and switching operations. The higher the working voltage the lower is the current, and consequent excess pressures are not so relatively high. The kind of safety factor employed in a standard range of insulators is as follows:—

Working volts.	Flash-over volts.	Safety factor.
4,400	22,000	5
8,250	35,000	4·25
13,000	45,000	3·5
33,000	81,500	2.5
77,000	170,000	2.2

Usually such insulators are made of parabolic form, and so supported that a breakdown through the porce-

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lain or like material cannot possibly occur, the effect of the voltage rising sufficiently high merely being to give a flash-over from the insulator cap to the insulator base. Sometimes insulators are permitted to have interior passages unconnected to the atmosphere, whereas at other times an air connection is made. The latter is probably the more efficient.—"L. R."

Replies to Question 162.

The second prize (5s.) has been awarded to "A. A." for the folowing reply:—

Porcelain is the material in practically universal use at the present time for the manufacture of high-pressure and extra high-presure insulators.

For this purpose it must comply with the following essential requirements:—

(i.) Mechanical strength.

(ii.) Dielectric strength.

(iii.) Capability of withstanding sudden and violent changes of temperature.

(iv.) Freedom from porosity.

Manufacturers' lists have shown that porcelain will withstand compression stress up to a safe limit of 40,000 lb. per sq. in., and tensile stress up to 1,500 lb. per sq. in. Conditions (ii.) and (iii.) are satisfied, and by means of high surface glazing condition (iv.) is complied with.

Insulators can be roughly divided into two classes, (*a*) supporting or pin-type, (*b*) suspension type.

Supporting Insulators.—For high-pressure working up to a limit of about 60,000 volts an elaboration of the ordinary petticoat-type insulator, as used in telegraph and telephone work, is employed. Such an insulator must be designed to withstand the following three forms that leakage may take:—

(i.) Breakdown of porcelain dielectric.—Porcelain having a very high insulating value, the danger of direct breakdown of the dielectric between the line wire and the bolt is negligible with the thickness of this portion of the insulator which mechanical considerations alone demand.

(ii.) Surface leakage.—This is by far the most serious source of trouble met with in practice. Adverse atmospheric conditions, *e.g.*, rain, moisture, fog, etc., will enable leakage to take place over the exposed surface of the insulator. The necessity, therefore, arises for providing sufficient *protected surfaces* which will remain dry under adverse conditions. These protected surfaces are obtained by making "sheds," or "deep corrugations," in the body of the insulator, between the outer surface and the bolt-hole. Double-shed, triple-shed and multiple-shed insulators are used according to the voltages for which they are designed. Large sized multiple-shed insulators, however, owing to the difficulties met with in manufacture, are generally made in two or more parts, which are subsequently cemented one inside the other.

(iii.) Flashing over.—The lip of the outer surface of the top petticoat or bell is, in wet weather, at the same potential as the line-wire. The arcing distance is, therefore, then equivalent to the shortest air-path from this lip to the supporting pin of the insulator. This distance may obviously be increased to a safe one by increasing the radial lengths and the conical angles of the petticoats.

Suspension Type Insulators.—Above pressures of about 60,000 volts, supporting insulators are discarded from considerations of size and weight, and suspension insulators are made use of. These consist essentially of a number of insulators connected in series. Each unit insulator, for example, may consist of two porcelain shells cemented together, the topmost shell being provided with a metal hood and the lower shell having a split-pin cemented into it, the bottom portion of the pin forming a hook. This hook engages with a cross-pin on the metal hood of the next unit insulator below it. In this manner suspension insulators consisting of any number of such units may be built up for use with extra high-pressure transmission lines.

Corona Effect.—When two conductors at great mutual potential difference are gradually brought closer together, a point is reached where a continuous passage of energy begins to take place through the atmosphere. As the potential difference is increased or the distance between the conductors is diminished, this loss of energy becomes rapidly very great until finally the atmosphere in the immediate neighbourhood is completely broken down and arcing across takes place.

This phenomena is known as "corona effect," and consists simply of brush discharges from the conductors. It manifests itself at night as a luminous discharge accompanied by a more or less audible hissing noise. By reducing the dielectric stress in the atmosphere at the surface of the conductors, this brush discharge may be prevented For a given line voltage this may be accomplished by (*a*) increasing the distance apart of the conductors, (*b*) increasing the surface area of the conductors (*i.e.*, the diameter of the conductor).

Corona effect, although inappreciable at ordinary voltages, becomes of practical engineering importance at voltages of 60,000 and over.—"A. A."

Annual Outing.—The works of the "D.P." Battery Co., Ltd., were closed on Saturday last, on the occasion of the annual works outing, when Blackpool was again visited. The party travelled in five reserved saloons on a special train, and a very long day was thoroughly enjoyed.

Competition.—According to the *Board of Trade Journal*, important orders have been obtained from the British West Indies by Canadian and American firms recently because of the presence on the spot of their representatives or their willingness to send out representatives. Cases in point are the supply of an electric lighting plant to San Fernando, Trinidad, and to towns in the Leeward and Windward Islands by an American firm.

University College.—Particulars of the arrangements in the Faculty of Engineering for session beginning on October 1 are now available on application to the Secretary of the College. The engineering departments have just been extended and re-equipped. The laboratories, which are so extensively known for fundamental discoveries in wireless telephony and telegraphy, are also being extended.

Northampton Polytechnic Institute.—The new issue of the "Educational Announcements" (session 1923-4) evening classes is now ready. Any readers contemplating studying any branch of engineering should finally look into the question at once. Classes begin on Monday, the 24th inst. Enrolments on Monday next. The Institute is in St. John Street, Clerkenwell, E.C.1.

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THE Cable Makers' Association call the attention of manufacturers, sellers and buyers of electric cables to the fact that the letters

C.M.A.

have by Permission of the Board of Trade been registered as a trade mark (Nos. 422219-20-21). This mark is the property of the Association and is usable only by members of the Cable Makers' Association under the authority of the Association. The use of such mark by others on electric cables is an infringement of this trade mark.

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The India-Rubber, Gutta-Percha & Telegraph Works Co., Ltd.
Johnson & Phillips, Ltd.
Liverpool Electric Cable Co., Ltd.
The London Electric Wire Co. and Smiths, Ltd.
Siemens Brothers & Co., Ltd.
St. Helens Cable & Rubber Co., Ltd.
Union Cable Co., Ltd.
Western Electric Co., Ltd.

Advertisement of the Cable Makers' Association, Sardinia House, Sardinia Street, London, W.C.2.

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THE LAST WEEK!

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SHIPPING, ENGINEERING AND MACHINERY EXHIBITION

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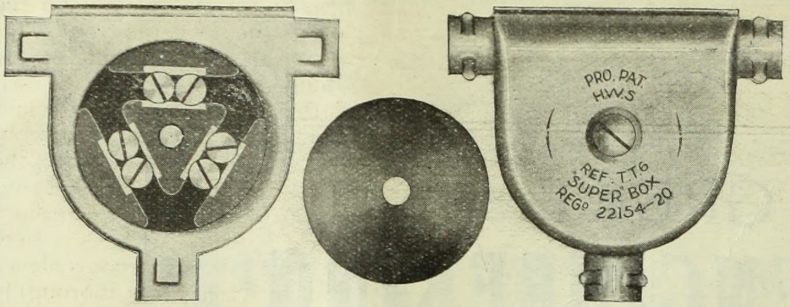
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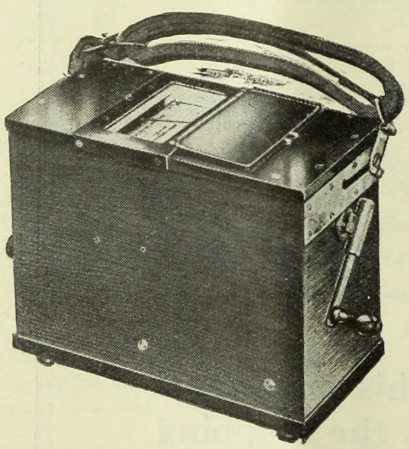
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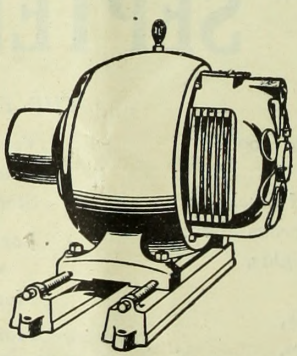
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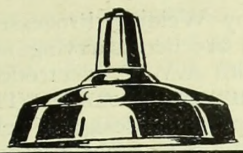
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Current Topics.

The initial letters of this paragraph will be familiar to many of my readers, especially in the North, and will doubtless reawaken memories of a happy, joyous holiday now only a memory of our all too brief summer. I like my holiday late, preferably in early September, for three main reasons. First of all one sees all one's friends leaving for the country and seaside and returning bronzed and benefited, but with a long spell of autumn and winter ahead before the next relief from daily toil. When all have returned one has the satisfaction of realising that *the* holiday is yet to come; that September weather is generally reliable; and that when it is over Christmas won't be over long in coming. So give me merry Douglas in early September.

I.O.M.

However, editors are stern, unbending folk, and I have had to make a solemn promise not to disappoint you in the matter of my weekly notes; so here goes. Since I was last in the island it has made considerable progress electrically. Douglas now boasts a power station of its very own, and many of the boarding houses and hotels have made a beginning with electric light. The establishment which is my temporary abode has only got juice on the ground floor at present; there was no time to wire the building throughout before the season opened, but next year they hope to extend it throughout, and no doubt many other hotels and boarding houses will follow suit. The winter months should provide a harvest for local wiring contractors, as there are literally thousands of rooms to be wired and fitted, and the work cannot be carried on between May and September.

The famous holiday camp is already well equipped with electric light, and has added a considerable extension to its dining accommodation with flat roof promenade, from which a splendid view of the Bay can be obtained. By far the most interesting addition since last year is an electrically driven escalator, which, for the modest toll of twopence, deposits you safely on the upper terrace and saves a back-aching climb. It is one of the longest escalator trips I have yet taken; working on the principle of the continuous elevators which take you up to the summit of an incline at the Fun City, whence you descend seated on a mat and at a speed proportionate to the gradient, your bodily weight and the co-efficient of friction between mat and slide.

A continuous chain of seats travels steadily up the gradient, and having passed the turnstile you select a passing chair, sit comfortably therein, and in the course of a couple of minutes or so, find yourself arriving at an upper platform, where an attendant assists you to land safely before your chair passes on, turns over, and commences its return journey to the foot of the hill. It is quite a novelty and was doing a brisk business when I made the ascent at about 5 p.m. for a stroll through the camp during tea-time. Incidentally, this camp has every modern convenience and affords men and youths facilities for a thoroughly enjoyable and inexpensive holiday in the Isle of Man. You can either occupy a tent or a hut, according to choice. Meals and music are provided in an immense dining-hall, and there are all sorts of amusements, tennis courts, etc.

Another electrical pastime which has just begun to grip the islanders, especially those living inland in remote country districts, is broadcasting. With a three, four or five-valve combination all the principal broadcasting stations in this country, together with Paris, can be picked up, and with a minimum of interference, since there are no electric trams in Douglas and comparatively few motors or power installations, at present at all events. In conversation with a leading man in the trade this week he told me that the only trouble he had experienced was from atmospherics and shipping; and it is probable that the Isle of Man at present represents one of the best reception areas for broadcasted music and speech.

Reverting to the holiday camp, which of course possesses an up-to-date receiving set and loud speakers, I was told they had difficulty in picking up 2L.O. This, however, is probably accounted for by the bad disposition of the aerial. The one I saw ran a few feet above, and almost parallel with, an extensive corrugated iron roof, so that the screening and capacity effects must have been considerable. There are ample alternative routes, and the camp being itself at a considerable elevation, should have no difficulty in satisfactorily solving the problem of an efficient aerial.

At the Palace Ballroom they have a very effective reflecting arrangement for disseminating the coloured "limes" during certain dances. The arrangement consists of a suspended sphere, capable of being slowly rotated in either direction. The lower hemisphere consists of a number of small mirrors, mounted closely together and resembling the facets of a cut jewel, each being set at a slight angle to the neighbouring mirrors on either side, above and below. To obtain the effects the ordinary floor lights are extinguished and four or more different coloured limes projected on to the sphere, which is simultaneously set rotating. The result is a kaleidoscope of different coloured flashes passing constantly over the moving couples on the floor, and the effect from the spectators' viewpoint is most fascinating.

I travelled the other day on what purports to be the smallest miniature railway in the world. It is only single track, about 18-inch gauge, and runs along the edge of a cliff in Groudle Glen, one of the island's many beauty spots. The cars are open-sided, seat two adults abreast, and a "train" will accommodate from 30 to 40 people. The route is quite short, from the head of the Glen to the coast, where the principal

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attraction is a brace of sea-lions, most interesting to watch at feeding-time. The line is electrically operated, a battery locomotive being utilised to draw the cars up what is, in places, quite an appreciable grade. Altogether, the Isle of Man boasts quite a number of interesting electrical novelties, and these are likely to increase now that a power supply, independent of the Manx Electric Railway system, is available for any purpose.

ELEKTRON.

THE SHIPPING, ENGINEERING AND MACHINERY EXHIBITION AT OLYMPIA.

(Continued from page 476.)

GALLERY EXHIBITS.

Stand No. 9.—The Igranic Electric Co., Ltd. (147, Queen Victoria Street, E.C.4) are making a "wireless" display of great interest, particularly to enthusiasts in the new art. The exhibit comprises their Honeycomb Duolateral tuning coils, for which a very high degree of efficiency is claimed, due to the peculiar method of winding, audio frequency amplifying transformers, variometers, variocouplers, filament rheostats and battery potentiometers. They also show a new method of mounting honeycomb coils on gimbals or studs in lieu of the better known plug type of mounting. Besides allowing for the angular relation of one coil to another to be varied, this mounting also permits the coil to be rotated about its own axis, thus providing extremely accurate and fine tuning. The self capacity, always an undesirable factor in tuning coils, is still further reduced, since the gimbals, which also act as the terminals of the coil, being positioned diametrically opposite, allow the maximum space between the in-going and leading-out conductors. In addition there is on view a complete range of new models of coil holders, and many novel features have been introduced. A fascinating little instrument is the "Vernob," which has quite recently been patented. As its registered name implies, this instrument consists of an ebonite knob for attaching to variable condensers, variometers, tuning coils and the like by which, in addition to a movement co-incident with the speed of the knob, a vernier movement may be obtained due to an ingenious self-contained mechanism housed in the knob itself. The vernier movement enables a slow movement of approximately one-fourth of the peripheral speed of the knob to be obtained, so that both coarse and fine tuning is available whilst using only one knob. There are no gears used in the mechanism, which makes the articles all the more attractive. The workmanship and finish of all the exhibits is in keeping with the reputation of this well known firm.

Stand No. 18.—Burlectas, Ltd. (11, Pancras Lane, Queen Street, E.C.4), are making a show of their Staines Art Ware electric table standards. The stems are made in several graceful designs under a new process and are variously coloured and decorated. They are supplied with or without silk shades to match, and make a charming addition to artistically furnished rooms. Agents are being appointed.

MAIN HALL.

Stand No. 4 (Row A).—S. Rentell and Co., Ltd. (36, Maiden Lane, Strand, W.C.2), proprietors of this journal, have a particularly extensive range of books dealing with the various branches of engineering, as well as books on shipbuilding and shipping. The chief books from the leading publishing houses as well as the company's own publications are offered for sale, and every facility is given for inspection. Inquiries are invited.

Stand No. 13 (Row A).—Alloy Welding Processes, Ltd. (14-16, Church Street, N.1) are here carrying out welding demonstrations daily with A.W.P. electrodes, including those for copper, brass and bronze. The generating set used comprises a patented design of self-stabilising dynamo driven by a 10 h.p. Gardner internal-combustion engine, the set complete being mounted on a channel steel welded bed-plate, to which wheels may be attached. The equipment is ingeniously housed and protected against the weather. The dynamo gives an open circuit voltage of 70, which drops to the pressure required across the welding arc as soon as the operation commences. The output can be adjusted by field control between 50 and 200 amps.

Stand No. 14 (Row A).—G. D. Peters and Co., Ltd. (Caxton House, S.W.1) here demonstrate the Wilson Plastic Arc system of electric welding. The system is arranged so that constant voltage and uniform heat at the weld is automatically maintained.

Stand No. 17 (Row A).—Wm. Hamilton Wilson (5 and 6, Bank Broadway, Kingston Hill, Surrey), shows a most interesting collection of H.T. appliances for wireless telegraphy, and thermo-electric measuring instruments for H.F. currents.

Stand No. 16 (Row B).—The Premier Electric Welding Co., Ltd. (proprietors, Nobel Industries, Ltd.), of Abbey Wood, S.E.2, have among their extensive range of electric welding equipment and accessories their multiple arc welding plant, which has been designed for supplying two or more operators. This plant is the subject of a special patent. The high starting voltage necessary for arc welding is obtained by having in series with the main generator, a small dynamo of the exciter type giving a small current output at 35 volts, this dynamo being cut out automatically after the arc is made. The most important features of the plant are claimed to be:—(1) Extreme economy in running costs, and (2) the elimination of large wasteful resistances. It is claimed also that the power required to drive this equipment is approximately one-half that of the ordinary multiple operator plant. It has all the advantages of the single operator type drooping characteristic welding generator. The special contactor gear fitted is very ingenious. A.C. welding plant, single operator D.C. machines, and various "Premier" flux covered electrodes, including the new high carbon (.5 per cent. carbon) electrodes are also exhibited.

Stand No. 3 (Row C).—Drummond Bros., Ltd. (Onslow Street, Guildford, Surrey), show a series of machines and engines under the name "The Willing Worker." Besides examples of the 3 b.p.h. paraffin engine, concrete mixers, diaphragm pumps, drag saws, force pumps, etc., there is "The Willing Worker" house lighting set. In this the 3 b.h.p. paraffin engine (which starts from cold on a small drop of petrol, a float feed carburettor being used) is belted to a 1 kw. dynamo. Batteries are supplied, and the switchboard is carried on a steel frame.

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In addition to the Brown Gyro-Compass on Stand No. 6 (Row C) S. G. Brown, Ltd. (Victoria Road, North Acton, W.3), show their well-known head 'phones and loud speakers for broadcast reception. A new development in loud speaking telephones, the Electro-Megaphone, is also demonstrated. As its name implies this is a telephone through which orders can be called in noisy situations, or over very great distances from the receiver trumpet. Ordinary speech is reproduced, magnified, so loud as to be audible sixty yards in the open air from the receiver. The apparatus in thus suitable for use on board ship, and in factories, power stations, goods yards, and an infinite variety of industrial and other situations. Purity of speech is a strong feature. Several types are manufactured, together with switching accessories enabling rapid changing over to be made to various points to be spoken to.

Stand No. 9 (Row C)—The Cambridge and Paul Instrument Co., Ltd. (45, Grosvenor Place, S.W.1), display a large number of their ingenious, well-made and accurate instruments, including CO_2 recorders, gauges of various kinds, thermometers (recording, distance, etc.). Also thermo-electric, radiation and optical pyrometers, apparatus for automatic temperature control, workshop potentiometers and various electrical testing instruments.

Stand No. 14 (Row C).—The Consolidated Pneumatic Tool Co., Ltd. (170, Piccadilly, W.1). The very extensive range of pneumatic and electric appliances made by this firm is well represented by a large selection. Included in the electric appliances are their rivet heaters, drills, grinders, hammers and hoists, tyre heaters, electrodes, "Weldrics" patent arc welders, particularly intended for boiler repairs and high-class repair work generally, also "Weldrines" for repair work on tramways and railways, filling holes in castings, etc.

Stand No. 3 (Row D).—The Swedish General Electric Co., Ltd. (5, Chancery Lane, W.C.2). Various D.C. and three-phase motors designed for heavy industrial use may be seen on this stand, where is also a three-phase variable-speed commutator motor, type F.S. This has a wide range of speed control (3 to 1) by a mechanically or electrically operated brush-shifting device. The speed is quite independent of the load, and the efficiency and power factor are high for all speeds within the speed range. For individual tool driving off a single-phase circuit there is the "Century" self-starting repulsion induction motor, which is made in sizes from $\frac{1}{8}$ h.p. to 40 h.p. For lift work there is the single-phase reversible commutator motor, type S. Other interesting machines, including a 250 h.p. three-phase motor for use in fiery mines, are also shown, as well as control gear and a new type of overload relay.

Stand No. 9 (Row D).—Elkay Electrical Manufacturing Co., Ltd. (4, Southampton Row, W.C.1). Here are to be found examples of various switches, meters, fuses, etc., also H.T. power apparatus, automatic oil switches, etc.

Stand No. 15 (Row D).—Hesco, Ltd. (Kingsway House, Kingsway, W.C.2). Among a variety of trucks, stackers, cranes and appliances for handling all kinds of goods are electric trucks and tractors; also a "London" truck with a Ransome's and Rapier's trailer crane. This is of 1 ton capacity. The arrangement provides a handy electric crane, quickly attached to, but not interfering with, the electric truck for standard use.

Stand No. 19 (Row D).—W. Goodyear and Sons, Ltd. (Dudley, Worcs) show the latest models of the well-known "Greenbat" electric trucks, including a 2-ton standard elevator truck on new and improved lines.

Stand No. 1 (Row E).—The London Electric Firm (Brighton Road, Croydon).—This firm are showing several of their numerous designs of searchlight projectors, also their patent flexible couplings, winches, contact suspension gear, etc. Their subsidiary, the Electric Heating Co., have for inspection their electric irons, kettles, soldering-irons, boiling-rings, etc.

Stand No. 4 (Row E).—Laurence Scott and Co., Ltd. (Gothic Works, Norwich), who specialise in D.C. machinery and control for special purposes, have, as usual, a most instructive exhibit. Most of the plant shown has been designed to meet seafaring conditions. Included is their standard self-contained 3-ton worm-geared cargo winch, the whole equipment, including foot brake, magnetic brake and control gear, being enclosed and watertight. There is also an example of the all-electric steering gear ("Scott" patents). Control is effected on the Wheatstone Bridge principle. The electrical equipment comprises a motor generator, the terminal voltage of which is varied by the Bridge controller, and a main motor driving the Wilson-Pirrie gear.

Stand No. 8 (Row E).—Hobdell, Way and Co., Ltd. (45, Church Street, Minories, E.1).—Besides models and samples of various classes of insulation and a range of engineering sundries, the firm show "Durite" red chrome leather belting, which is unaffected by heat or damp. Another speciality is their "Hobrake" bonded asbestos lining for brakes and clutches.

Stand No. 10 (Row E).—The Anglo-Swedish Electric Welding Co., Ltd. (Wood Wharf, Greenwich, S.E.10). This company has the exclusive rights of the Kjelberg system of arc welding and shows a comprehensive series of test pieces, also models and details of the only large boiler so far constructed in this country with the main joints welded instead of riveted.

Stand No. 12 (Row E).—The Midland Dynamo and Motor Repairs Co., Ltd. (64, Belgrave Gate, Leicester). The "Quickway" coil-winding machine is here being demonstrated. All sizes of armatures or stator coils can be made. The machine is of equal service for rectangular or square conductors, as well as standard round section conductors, and can be set up to the required dimensions of any coil by an intelligent person in less than five minutes. The conductors are arranged to be drawn through a friction clamp to adjust the necessary tension. The winding position is such that the wires require practically no handling as they are being fed into position, and by means of the clutch the machine revolves and draws the wire along the track, the sides of which are arranged at an angle equivalent to the axial radius of the slot that the coil is to occupy. Every wire is wound in exactly the position in which it will lie when the coil is fixed in the armature or stator, and no displacement is likely to occur in handling. As soon as the requisite number of turns has been made, by the movement of a lever through the clutch drive, the coil is completed

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and is ready for taping. The half-turn of six small levers releases the coil from the machine. The time required for the completion of the average coil is two minutes.

Stand No. 22 (Row E).—H. C. Slingsby (89-97, Kingsway, and Great Queen Street, W.C.2). Here is a selection of some sixty of the 1,900 varieties of trucks, etc., made and catalogued. Included are several electric trucks, tractors, etc.

Stand No. 23 (Row E).—Lanston Monotype Corporation, Ltd. (43, Fetter Lane, E.C.4). Besides the Radbore Head Square Drilling Attachment and other of the firm's specialities are examples of the "Safe Economy" electric iron and a large model of the switch in the handle, showing its operation and four series breaks. The heating circuit is only "on" when the grip switch in the handle is closed by the hand lightly gripping the handle. The grip switch can be attached to other devices, such as vacuum cleaners, portable drills, grinders, etc.

Stand No. 25 (Row E).—Buckley Saunders and Co., Ltd. (8, Princes Street, Westminster, S.W.1). This exhibit comprises various spot, butt and seam welders adapted for several purposes. A rivet heater is also shown, also a chain welder and portable arc welders.

Stand No. 27 (Row E).—A very attractive display of insulated copper wire for magnets, dynamos and motors, as well as a thoroughly representative selection of other of the company's wires, is made by London Electric Wire Co. and Smiths, Ltd.

(To be continued.)

ELECTRIC LAMP DEVELOPMENTS.

The history of the development of electric lamps affords an interesting study, and, whilst revealing the many difficulties which have been overcome, shows the possibilities of further improvements and the directions in which progress is likely to be achieved. The whole subject was reviewed recently by Dr. H. Lux in the *Elektrotechnische Zeitschrift*, and, from a consideration of the physical factors involved, it was shown that light production by incandescence is inherently incorrect policy. The theoretical limit of efficiency attainable by this means is 14½ per cent., and even this figure cannot be reached by the technical means at present available. Recent additions to our knowledge of atomic structure and the development of light by electronic motion inspire the hope that we may ultimately obtain really economical sources of light by direct electronic excitation, with the elimination of the principle of incandescence. By the complete conversion of applied energy to light an efficiency of the order of 650 + 33 lumens per watt (about 0.02 watt per spherical candle-power) would be obtainable. Beyond this limit we cannot go, since it is dictated by the physiological nature of the human eye. As a matter of fact, however, we are at present further from a general application of existing sources of light in rational manner than we are from a solution to the much more difficult problem of producing light itself by rational means. Of the two problems, that of "good illumination" is by far the more important.

Arc Lamps.—The first electric lamp was, of course, the electric arc, and in its "open" form, with cored carbons, it yields about 15 lumens per watt using direct current and 6½ lumens per watt using alternating current. (*Note.*—1 lumen $= 4\pi = 12.57$ spherical candle-power.) The burning period of the open arc is about 7 or 8 hours per pair of carbons. In this respect the enclosed arc, burning 200 hours or so, represents a great advance, but the efficiency is relatively low (9½ lumens per watt on D.C.), and the light is very unsteady. For all photographic purposes, including blue-printing, the enclosed arc is most valuable, owing to the highly actinic nature of its light.

The flame arc, still the most efficient artificial illuminant, uses impregnated carbons and yields about 40 lumens per watt. By enclosing the arc in a globe through which a vigorous circulation is established, carrying all fumes into a condensing chamber, the formation of corrosive deposits on the glass is prevented.

From the fact that the temperature of the positive crater is constant (about 4,200 deg. C. absolute), whatever the current loading, it may correctly be deduced that melting and evaporation are there in progress. Lummer found that, by increasing the pressure to 22 atmospheres (thus raising the boiling point of the carbon), the temperature of the crater was raised to about 7,600 deg. absolute, and the intrinsic brilliancy to 165,000 c.p. per sq. in., compared with 105,000 c.p. per square in. for the crater of the ordinary carbon arc. Unfortunately this line of development cannot be followed commercially, because no known transparent material will withstand more than 2 or 3 atmospheres at the working temperature of an arc lamp globe, and, under these conditions, there is no appreciable improvement in efficiency, but, on the other hand, a marked decrease in reliability.

A development which is of considerable importance in regard to searchlights, but has not yet been applied to ordinary illumination, is the running of flame arcs at abnormally high current density. By using 250 amps. with a 16-mm. carbon (compared with 150 amps. for the 36½-mm. carbon of an ordinary searchlight) a crater brilliance of 730,000 c.p. per sq. in. and a temperature of 5,100 deg. absolute has been reached. Special means are employed to secure a deep crater and to prevent its breaking through the rim of the carbon.

The magnetite-copper arc (about 25 lumens per watt) is not much used outside America; the light is somewhat unsteady, and the main advantage of the lamp is its long-burning period—150 to 180 hours on one negative, the copper positive being practically undamaged.

The well-known arc-incandescent "Pointolite" lamp employs a tugsten arc in vacuo, and gives about 12½ lumens per watt. This lamp is so close an approach to a point source that it is particularly useful for projection purposes.

Discharge Through Vapours and Gases.—Though it is unquestionably an arc lamp, the mercury vapour lamp differs from the other types already considered, in that light is derived entirely from the luminescence of the vapour column. The light is, therefore, strongly coloured with green, the characteristic of the mercury spectrum. By enclosing the arc in quartz and raising both the vapour pressure and the temperature of operation, the remarkable efficiency of 54½ lumens per watt is reached, but the colour of the light is still such as

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GLOVER'S

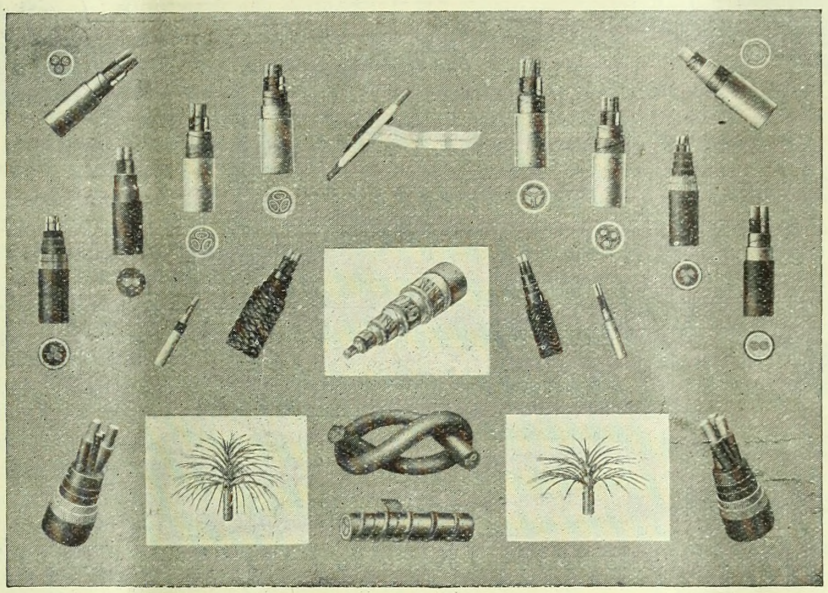
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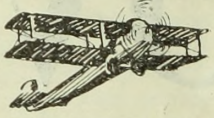
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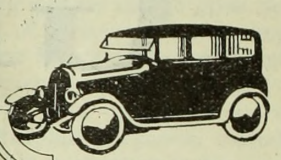
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START OUR AEROPLANES



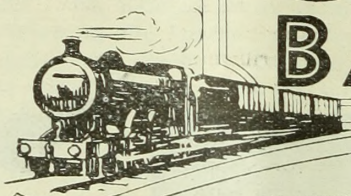


LIGHT OUR HOMES

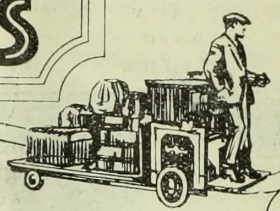
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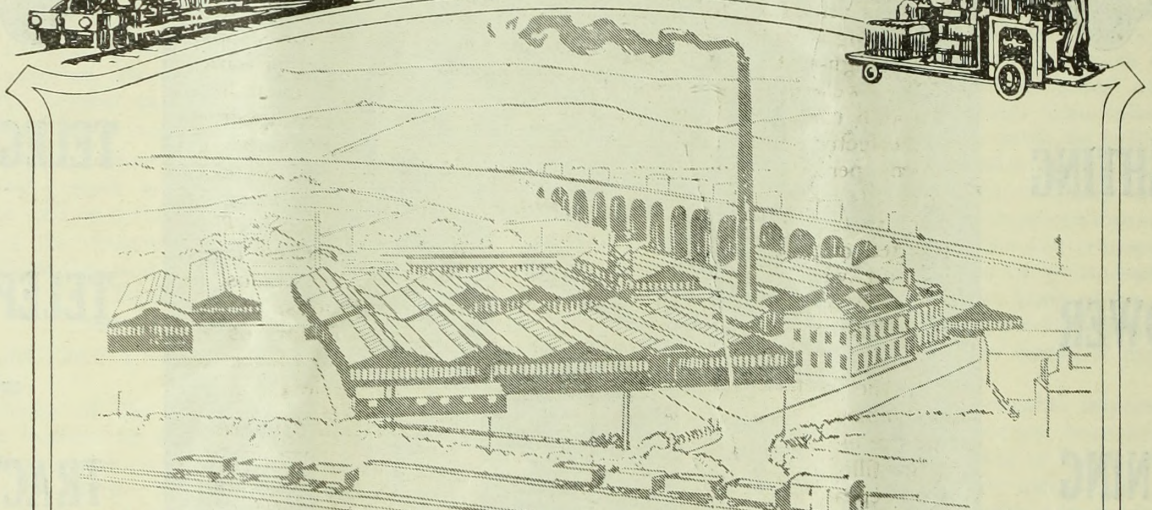
Chloride BATTERIES

LIGHT OUR TRAINS



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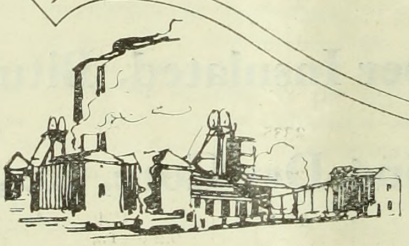




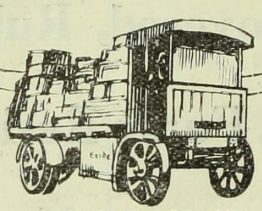
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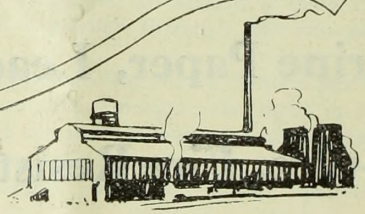
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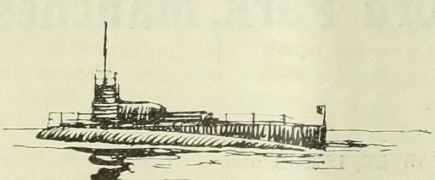
LIGHT OUR COAL MINES



WORK OUR LORRIES

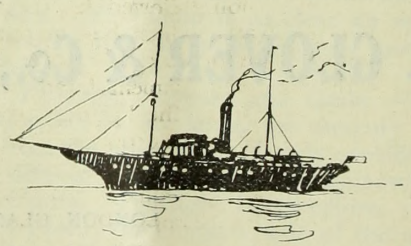


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to render it inapplicable for general illumination. Many attempts have been made to correct the light by adding red rays, e.g., from a carbon filament or from a red-flouresing substance, but no satisfactory solution of the problem appears yet to have reached the market. Possibly the most promising attempt is the use of an arc between a tungsten sphere and a pool of mercury in a glass bulb. If the mixing of differently coloured lights from separate sources could be accomplished easily and efficiently, there would be good prospects for the associated use of mercury and neon lamps, the latter giving a pronounced red light to the extent of some 25 lumens per watt, if an arc be established in neon between an iron anode and an amalgam cathode. The efficiency of the recently introduced neon glow discharge lamp is much lower, viz. (according to Dr. Lux), 0.85 lumen per watt in the case of a 0.3-m.s.c. lamp consuming about 5 watts. The neon glow discharge lamp is, of course, used not as a high-efficiency source, but because it provides, with nominal expenditure of energy, a light which is attractive for advertising purposes and suitable for night lights, etc.

The Moore lamp utilises a high-tension discharge through nitrogen—giving a rosy-yellow light at about 8½ lumens per watt; or through carbon dioxide, the light being then almost perfectly white but the efficiency being only 3 lumens per watt. The chief drawbacks of this lamp are:—(1) The fact that the tube, which is anything from 50 to 500 ft. in length, must be built up and evacuated on site; (2) the fact that a step-up transformer—and, with D.C. supply, a converter—are required to furnish the 5,000-volt to 20,000-volt A.C. needed at the lamp terminals.

Incandescent Filament Lamps.—The history of the glow lamp—from the time, in the 'seventies, when the Edison and Swan carbon filament lamp first made possible the "sub-division of the electric light," to the perfection of the modern gasfilled lamp—has often been written and need not be repeated in detail. The plain carbon filament lamp yields about 3.6 lumens per watt, and the metallised carbon filament lamp about 6 lumens per watt. The Nernst lamp, with its output of 8½ lumens per watt—attributable to its higher filament temperature (2,600 deg. C. absolute, compared with 2,135 deg. in the ordinary carbon lamp), and to its selective radiation in the visible range—would soon have driven the carbon lamp from the field, notwithstanding the slight delay in lighting up due to the fact that the Nernst filament must be heated before it becomes conducting. However, before the Nernst lamp could surmount its childhood's troubles, the osmium lamp was introduced. This required no pre-heater, and had an efficiency as high as that of the Nernst lamp. It was soon followed by the tantalum lamp (7.8 lumens per watt), which had manufacturing advantages to compensate for its rather lower efficiency, and then came the tungsten filament lamp, which has swept all before it so far as the lighting of interiors is concerned, and, indeed, in the majority of exterior lighting schemes. The medium c.p. vacuum type tungsten lamp yields about 10 lumens per watt (rising to 14 lumens in high c.p. lamps), and the gasfilled type yields up to 21 lumens per watt. Both types are built in different forms to meet specific requirements, and it is doubtful whether carbon lamps, which are still used sometimes where vibration is severe, have really any superiority over the tungsten type in point of mechanical strength. Only after long service do drawn-wire tungsten filaments show any sign of brittleness.

The nitrogen-filled tungsten lamp can be relied upon for 500 hours' burning life (and generally much longer), and can be made, if required, in sizes up to 16,000 watts. It is difficult to build, however, in sizes lower than 500 watts. Argon, by its higher dielectric strength and lower thermal conductivity, makes it possible to build gasfilled lamps in sizes as small as 50 watts. The efficiency of gasfilled lamps below 150 watts is little, if any, higher than that of vacuum type tungsten lamps, and the life of the former is shorter. The only advantage of small gasfilled lamps compared with vacuum lamps is, says Dr. Lux, the whiter light and the more favourable distribution curve of the former. The intrinsic brilliance of the filament in a gasfilled lamp is very high—about 4,650 c.p. per sq. in., compared with 870 c.p. per sq. in. for the vacuum type lamp—hence it is essential that gasfilled lamps for use in rooms or workshops should be screened to avoid glare. Suitable diffusing fittings, reflectors, or opalescent lamp bulbs must be used.

The range of size and applications of gasfilled tungsten lamps is extraordinary. From 600 to 250,000 lumens (*i.e.*, from 50 to 20,000 spherical c.p.) can be obtained from a single lamp, and, in addition to the lighting of homes, shops, offices, workshops, streets and open spaces, gasfilled lamps are used for light-houses, photographic studios, optical projection, and many other applications.

An instructive summary of the operating conditions of various lamps and of the optical efficiency of the latter is given in Table 1.

TABLE I.—OPERATING CONDITIONS OF ELECTRIC LAMPS.

Type.	Temperature deg.C. absolute.	Intrinsic brilliance C.P. per sq. in.	Visual efficiency per cent.
Carbon fialment 3.9 watts/m.h.c.p. ...	2135	320—350	0.52
Carbon Metallised, 2.5 watts/m.h.c.p. ...	2270	525—580	—
Tantalum	2200	640—755	1.0
Nernst	2600	930—2,600	0.84
Tungsten, vacuum 1.2 watts/m.h.c.p. ...	2335	870	1.8
Tungsten gas-filled 0.67 watt/m.s.c.p. ...	2745	3,500—4,100	3.4
Mercury vapour in quartz at 150 v....	5273*	1740	6.8
Moore	—	0.23—1.45	0.85
Plain Carbon Arc—Arc	—	10,400—46,500	2.2
,, ,, ,, Crater	4200	104,000	
Flame Carbon Arc—Arc	—	3,500—5,800	4.8
,, ,, ,, —Crater	3500(?)	—	
Beck searchlight-Crater	5100	730,000*	—
Lummer high pressure, enclosed arc—Crater	7600	1,650,000*	—
Sun at zenith... ...	6000	870,000	11.8(?)

* Apparent.

Limitations of Light by Incandescence.—In the case of those illuminants which depend upon incandescence as distinct from luminescence, there is a fairly simple and definite relation between temperature and intrinsic brilliance. The brilliance increases very rapidly as the

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temperature is raised, hence the advantage of raising the temperature of incandescent illuminants. The true efficiency of the source of light is, however, determined by the ratio of the luminous to the total radiation. It is possible to predict with fair accuracy the radiation at different wave-lengths from a body at a stated temperature. A different curve is obtained for each temperature, and the ratio of the area below the curve in the visible range—from 700-800 $\mu\mu$ (red), to about 400 $\mu\mu$ (violet)*—to the total area below the curve gives the "energy efficiency" of the source, *i.e.*, the ratio of the *energy* radiated in the visible range to the total energy radiated. The eye is not, however, equally sensitive to all colours; it is most sensitive to the wave-length 556 $\mu\mu$ (yellow-green), and, taking the sensitivity at this wave-length as 100 per cent., the effect produced by equal amounts of energy at other wave-lengths may be summarised thus:—

Colour.	Wave length.	Percentage Effect on Eye.
Violet	400$\mu\mu$	Nearly zero.
Blue	450	3.6 per cent.
Blue-green	500	34.1 ,,
Yellow-green	556	100 ,,
Orange-yellow	600	63 ,,
Orange	650	9.4 ,,
Red	700	Nearly zero.

* $\mu\mu$=1 millionth of 1 mm. and is a convenient unit in which to measure the wave-length of light.

Correspondence.

BROADCASTING.

To the Editor of ELECTRICITY.

SIR,—Your criticism in the issue of ELECTRICITY of September 1 of the findings of the Committee in connection with broadcasting appear to me to deal with it from one side only. You have not made any reference to causes that tend to kill this new and instructive, as well as entertaining, innovation.

What of the ring around all valves? the buying of various crystals and retailing them in small pieces that brought in the retailer 200 and 300 per cent profit? The same in connection with B.B.A. screws and nuts, wire sold as cat's whiskers, odd cuttings of ebonite and foil worked up as fixed accessories, and so on, right through with all accessories? And the quality and finish of a lot of this stuff soon gave dissatisfaction; even some of the more reputable material was only camouflaged with a little polish or lacquer. Then, take the ready-made panels and completed multiple sets; they are efficient, and generally contain decent material, but they are often the production of juvenile labour, who work sectionally from charts (not that I dispute their capabilities), but, in connection with their retail price, where do the expenses of production come in? Take a five-valve set costing £50 and analyse it: B.B.C. royalty about £3 10s., leaving £46 10s. to cover retailer's profit and maker's costs. Split that up, taking as an average that any panel can be constructed for £5 even if all parts are bought ready made. Again I say, "Who is killing the goose?" As regards competition, if you are referring to Germany, beyond 'hones wireless requirements are almost unknown to them, as at the present time they themselves import what little crystals, etc., they require from America; and, as far as I could ascertain when over there last month, there were only two firms touching it, and with existing import duties that is not a very profitable source of business to people over here. I conclude definitely that makers and retailers are to blame, not the B.B.C., nor are the suggestions of the Committee far wrong in the main.

Yours truly (fourteen years' reader),

OLD CON.

BRITISH EMPIRE EXHIBITION, WEMBLEY, 1924.

To the Editor of ELECTRICITY.

DEAR SIR,—May I suggest for the consideration of those who arrange visits to works and other centres of interest for the various scientific and engineering societies that during the coming winter the site of the great exhibition at Wembley would be a very suitable place to include in any such round of visits?

I believe there would be no great difficulty in obtaining passes from the authorities if the party is of a reasonable size, and although visits would have to be made during daylight, there is no doubt they would be of value and increase general interest in this enterprise. Even at the present time the buildings and constructional plant are most impressive to anyone interested in the engineering industry.—Yours faithfully,

J. W. BEAUCHAMP, Director and Secretary.

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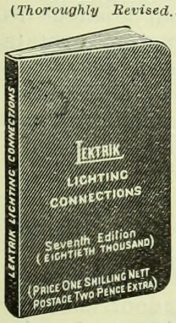
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Reviews of Books, &c.

[Books noticed in this column will be sent from ELECTRICITY *Office to any part of the world, for the published price, plus five per cent. for postage (minimum 2d.), and orders will be appreciated.]*

SENIOR MAGNETISM AND ELECTRICITY. By R. H. Jude and J. Satterly. 2nd edition. 446 pp., 260 figs. (University Tutorial Press, 6s. 6d. net.)—The object of this book is to provide a sound course in elementary magnetism and electricity for use in schools and colleges. A noticeable and very valuable feature is the inclusion of a large collection of simple and instructive experiments, all of which can be performed by the elementary student without elaborate or expensive apparatus. Another good feature is the inclusion of many worked examples in the text and the addition of problems to be worked by the student, answers being given in every case. The first part of the book deals with magnetism, which is a much easier line of ingress than electrostatics. The latter science is then introduced, and, in Part III., the authors deal with electrodynamic or voltaic electricity. The book is already well known, and in this, the second edition, its usefulness has been increased by the addition of some pages dealing, in a simple manner, with the principles of telegraphy and telephony. The volume is profusely illustrated with explanatory diagrams and is admirably arranged and produced.

MINING ELECTRICIAN'S HANDBOOK. By Lionel Fokes. (Wall and Sons, Ltd., Wigan; 10s. 6d.)—Written in the interests of mining electricians, mine managers and others concerned with the installation and maintenance of electrical gear in collieries, this essentially practical treatise, by an author who has himself had considerable experience of colliery work in this country, is a welcome addition to the literature on this important subject. Its twelve chapters, commencing with first principles, take the reader through practically all the present-day applications of electricity below ground in so far as the purely electrical portion of the plant is concerned, no mention being made of coal-cutters, haulages, pumps, ventilating fans or other machinery which relies upon electricity for its motive power. By thus confining his attention to the purely electrical features of mining work the author has chosen wisely and, as results prove, has provided a fund of useful information in concentrated form making for ready reference. Whilst direct current applications have their fair share of attention three-phase operation is dealt with more fully as representing the preponderating system and probably that upon which such a book of reference will prove more widely serviceable. Probably one of the most useful sections is that dealing with the drying of electrical machinery, several novel methods being described. This is one of the many difficulties colliery electricians have to contend with in maintaining their plant. The same chapter contains much useful information on testing also. Where simple calculations are called for, simple examples are given to illustrate the method, whilst most of the actual illustrations are prepared from line drawings by the author. In his remarks on pit shaft signalling we disagree with the author when he states that numerous systems have been devised, but few have met with any measure of success. There are several excellent pit shaft visual indicators made by leading electrical firms, and giving every satisfaction provided they are properly maintained. This section could well have been amplified to cover useful hints on the maintenance of one or two leading types of shaft signal indicators. Another section which has scarcely received the attention it deserves is that dealing with miners' electric lamps, which is dismissed in little more than six pages, no mention being made of the nickel-iron accumulator, a type which is rapidly coming into favour. Useful appendices which enhance the value of the book for reference purposes are some useful formulæ, tables, and a reprint of the general regulations affecting the use of electricity in mines.

SIMPLE CRYSTAL RECEIVING SETS AND HOW TO MAKE THEM. Edited by Bernard E. Jones. (Cassell. 1s. 6d. net.)—This book is uniform in style and price with others of the "Amateur Wireless" handbook series, and deals in a simple manner with the making of a number of Crystal sets representative of those in present-day use, and to all persons interested in building crystal sets the book contains much information of value.

The diagrams are simply and clearly drawn, and the illustrations generally good. The general view of the aerial and its supports and connections could certainly be improved upon, as nobody would advise an amateur to erect an aerial in the manner or position shown in this illustration.

The suggestion of a tuning card in order to note the positions of the various apparatus when receiving a certain station is to be recommended.

It is doubtful whether the genuine wireless amateur is interested in freak sets made in matchboxes, etc., although such information may appeal to some.

The eight illustrations of various crystals could very well have been omitted, as they do not convey any idea of the actual crystal, and the statement that "Tellurium is a light coloured metal" does not mean a great deal.

One can find in almost any book some brief statement that sticks, and the particular one of note in this instance is that a "crystal acts electrically very much in the same manner as a rachet wheel acts mechanically."

Much information contained in the chapter on converting low-resistance 'phones could well be revised. The illustration showing the magnet and spool mounted for winding shows a method we should not like to use. It would be impossible to wind the magnet spool in the manner described, if the illustration is followed, as the fixing nut would foul the wire every revolution. Further, with the fine gauge of wire used, it would be practically impossible for an amateur to wind a telephone coil, using an electric motor to rotate the bobbin or spool. The use of the gramophone spindle is certainly a little better suggestion, but even here we consider the idea doubtful. Amateurs would be far better advised to attach their bobbin to a small hand-drill of the Millers-Falls type, clamping this to the workshop vice. The writer has found this the only suitable method of winding the very fine gauge wires, say, from 44 to 48 S.W.G.

We agree with the remarks on the calculating of wire from a table of resistances; but cannot consider that any amateur would attempt to calculate by the weight method that is mentioned.

We like the graphical method of memorising Morse. This should be of value to many.

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THE COLLEGE TRAINED ENGINEER. By F. Bacon, with Foreword by Sir Henry Fowler. 23 pp., paper. (Heffer, 6d. net.)—This brochure is a reprint of the presidential address delivered by Prof. Bacon to the Engineering Association of Students of the South Wales Institute of Engineers. The main purpose of the address is to emphasise the importance of works' experience in forming the character of the engineer, and in enabling him to make better use of his college training. Prof. Bacon is a great advocate of all engineering students obtaining practical training as early as possible in their career. This address should be of the greatest interest to every engineer, whether he be the youngest apprentice or the largest employer of fully qualified engineers. Needless to say, it is also a thesis which should be studied by the parent who has the best interests of his son at heart.

AUTOMATIC TELEPHONE SYSTEMS. Vol. I. By W. Aitken, M.I.E.E. (Benn, 25s. net.)—Given a fundamental understanding of the several switch mechanisms, relays, etc., which in various groupings are combined in different circuit arrangements to accomplish, without human agency, the inter-switching of subscriber's circuits, constituting an automatic telephone system, the literature descriptive of that system necessarily resolves itself into a series of repetition descriptive paragraphs describing circuit performances, and illustrated in most cases by appropriate diagrams. The explanation of the behaviour of any given telephone circuit in plain text is never an easy matter, and, when a book mainly consists of such descriptions, more or less similar, it is not a very readable book in the ordinary sense, except to the student or telephone engineer seeking a better understanding of a particular function in the system he is studying or investigating. The author of this volume deserves every credit for having evolved a uniform method of treating his circuit descriptions, which, coupled with a special system of numbering the circuits on each diagram, rendering them easily traceable from end to end, greatly facilitates reference. In addition, a page size has been adopted which admits of comparatively large scale diagrams, and the avoidance of unnecessary cramping and crossing of wires. The book is divided into 83 sections, some of which are very brief, and deal generally each with a feature of one or other of the several automatic telephone systems described. It is an arrangement which facilitates possible re-arrangement and revision in the light of rapid developments now in progress. Although the Strowger system as originated and developed by the Automatic Electric Company, of Chicago, and latterly by the Automatic Telephone Manufacturing Company, Liverpool, is the original and well-established system, of which latter systems are in several instances derivatives, the author has included particulars of all the later entrants into the automatic telephone field, including the Western Electric Company's rotary and panel systems, and the Relay Company's system, which is based on the use of relays only, and includes no electro-mechanical switches. The author's long association with the art of telephony, and his close and intimate knowledge of telephone patents are a sufficient guarantee of the accuracy of treatment of his subject, and he makes due acknowledgment to the sponsors of the various systems described for the assistance they have severally rendered in furnishing first-hand information. Summarising, the book represents a very able compilation of the facts relating to the art of automatic telephony at the time it was written, and lends itself to early revision in the light of developments which are constantly taking place. The second volume, which is now also available, doubtless extends the history of progress in this fascinating subject to a still later stage in development, but must be the subject of a separate review. In the light of a difficult subject, the work of printer and publisher call for special commendation.

Trade Notes.

The following instructive publications are to hand from the **Metropolitan Vickers Electrical Co., Ltd.** (Trafford Park, Manchester):—*High Voltage Brushing Insulators*, *Oil Circuit Breakers—Type K*, and the *Breaking Capacity of Oil Circuit Breakers*.

Fuller's United Electric Works, Ltd. (Woodland Works, Chadwell Heath, E.), have issued a new list, No. 250A, on the subject of their block and standard plate type accumulators for motor-car lighting, ignition, wireless and general purposes. The construction of the block type cells is such that they are very robust, and not liable to injury by rough handling or accidental short circuiting. They hold their charge for a long time and sulphating to a serious extent does not occur.

The Prescot wiring system is well described and the component parts illustrated and priced in pamphlet P 181, just issued by **B.I. and Helsby Cables, Ltd.**, of Prescot, Lancs. A long list of the firm's manufactures is given in another leaflet.

The fourth number of the monthly "Benjamin Bulletin," recently issued by the **Benjamin Electric, Ltd.** (Brantwood Works, Tariff Road, Tottenham, N.17), deals with "automobile matters in general and Benjamin automobile products in particular." Included are articles on the wiring of Ford cars, the danger of fixed headlights on corners, and how the Benjamin Autoreelite can be used to illuminate the dark patches on the road, the Boyce moto-meter (a simple device to warn the driver should the engine run too cold or too hot), which is not fitted as part of the equipment on some makes of car, etc.

The September issue of the monthly trade price list emanating from **Siemens and English Electric Lamp Co., Ltd.** (38-9, Upper Thames Street, E.C.4), is now available. So is the Sun Co. monthly price list of electrical supplies. It is to be obtained from the **Sun Electrical Co., Ltd.** (118-120, Charing Cross Road, W.C.2).

The British Thomson-Houston Co., Ltd., have opened a new branch depôt at 31, Linenhall St., Belfast, where a well-equippped showroom and stores have been established. This depôt will deal with all business in the north of Ireland, which has hitherto been handled by the Co.'s Dublin office.

Applied Telephone Transmission.—This is the reprint of a paper which was read last October before the Inst. of P.O.E.E., by Mr. J. S. Elston, A.M.I.E.E., and has now been issued as a separate pamphlet. Together with the discussion it forms an interesting work of 94 pp., with various diagrams and tables, and we commend it to telephone readers. The price is 2s. 3d. post free from ELECTRICITY office.

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A POPULAR SCIENTIFIC WEEKLY JOURNAL
ELECTRICITY
A PRACTICAL TRADE JOURNAL

SEPTEMBER 21, 1923.

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BROOKHIRST A.C. CONTROL GEAR.

In designing a range of A.C. control gear, four methods of starting up the alternating current motor have to be considered, viz., (1) by switching straight on to the line, (2) by employing a change-over switch which will connect the motor first in star and then in mesh, (3) by the use of an auto-transformer starter to apply a reduced pressure before switching the motor across the line, and (4) in the case of slip-ring motors, by gradually cutting resistance out of the rotor circuit by means of a rotor starter.

It will be obvious that by reason of the necessarily high starting current with methods 1, 2, and 3, these are limited in their application. On the other hand, the squirrel cage induction motor is probably the cheapest and most reliable form of motor, and there is, therefore, a marked tendency to use these three methods of starting for higher powers than have previously been considered advisable. In designing a range of A.C. control gear which is to include overload features, this tendency is one which has to be reckoned with, since the huge discrepancy between the starting and running currents is liable to render the overload provision ineffective.

This difficulty has hitherto been met in one of two ways. Either the overload releases have been put out of action altogether during starting, or else they have been fitted with some form of time lag. The first of these methods obviously sacrifices all protection for the motor during starting. The second sacrifices only a part of the overload protection, since the time lags will, in most cases, allow the overload devices to operate instantaneously on a short-circuit, even during the period of lag. It may, however, prove the more dangerous method of the two in the case of applications where there is a heavy peak current on closing the "run" switch. In some cases the maximum adjustment of the time lag may not give a sufficient time for the "run" peak current to die down. To prevent the overload devices tripping, there will then be a tendency for the operator to increase the current setting of the trips, thus sacrificing protection in the running position. It will be obvious that even under the best conditions these two solutions present difficulties.

The finding of a more satisfactory solution of this problem has engaged the attention of Brookhirst Switchgear Ltd. (Chester) for some time, and in bringing out their new range of oil immersed A.C. control gear they have introduced the Brookhirst "Overload Restrainer." This device provides what is the equivalent of two current settings for the overload devices, one of these settings being operative during starting and one during running.

The restrainer is in the nature of a movable platform supporting the plungers of the overload trips. During starting this platform occupies such a position

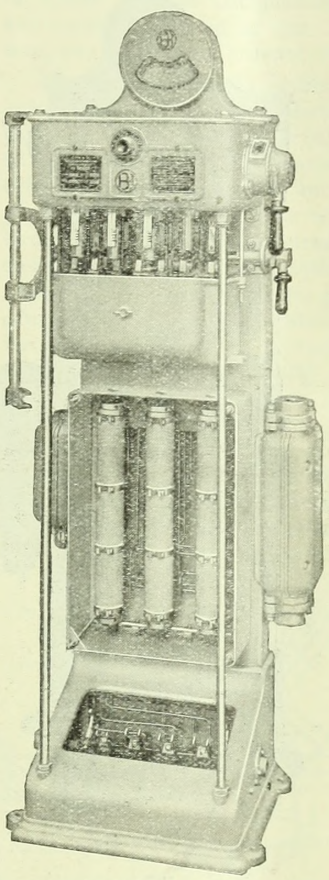


FIG. 1.

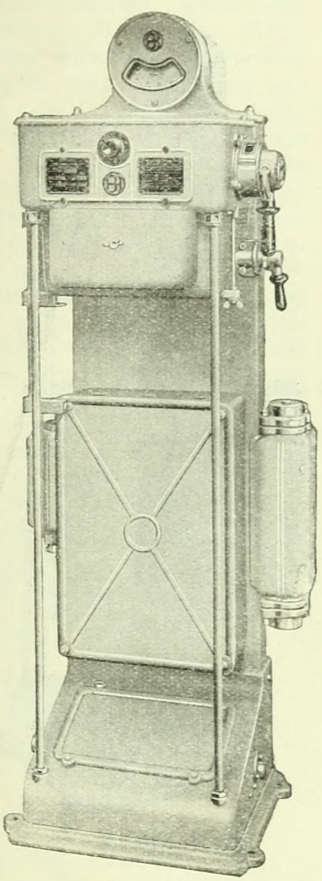


FIG. 2.

that the overload trips will only operate if the starting current is exceeded. After finally closing the "run" switch an interval elapses to allow the "run" peak current to die away, and then the platform is automatically raised to its normal or "running" position. In that position the overload devices will trip if the agreed margin over the normal running current is exceeded. In either the "starting" or "running" position, the exact currents at which the overload trips will operate can be adjusted to suit individual conditions.

By thus removing one of the principal difficulties, the Brookhirst "Overload Restrainer" should do much to raise the useful limit of the straight-on, star-delta, and

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auto-transformer methods of starting, and in view of the increasing popularity of the squirrel cage induction motor, this is a matter of some importance. This, however, does not exhaust the noteworthy features of the new "Brookhirst oil-immersed control gear, of which the several forms are illustrated in Figs. 1 to 5.

Fig. 1, 2 and 3 show a representative rotor starting pillar, with isolator and cover interlock. In Fig. 1 the isolator is "off" and the covers removed to show switchgear. In Fig. 2 the isolator is "on," and covers in position. In Fig. 3 the back covers are removed to show construction of the assembly case and arrangement of connections. The connection cover is removed on one side and a gland sectioned to show the interior. An oil-immersed auto-transformer starting pillar is illustrated in Fig. 4, while Fig. 5 gives

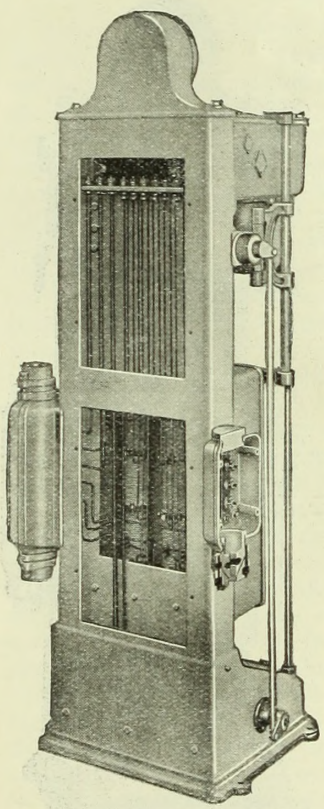


FIG. 3.

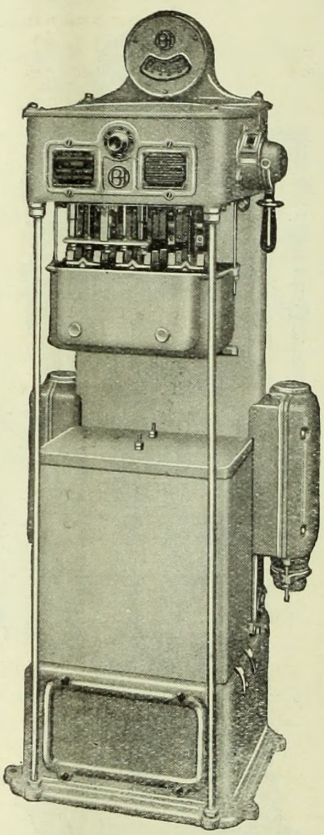


FIG. 4.

an idea of the arrangement of an oil-immersed wall type star-delta starting unit.

Whether for star-delta, auto-transformer or rotor contact the starting unit always comprises both a starter and a circuit-breaker. The unit is of the multiple switch design, the several switches being controlled by a Brookhirst patent ratchet handle. By means of this handle, the circuit-breaker is first closed and then, in correct sequence and with a slow-motion, step-by-step action, the starting switches, or the starting switch and auxiliaries, are operated. A noteworthy feature of this construction, from the user's point of view as well as from that of the manufacturer, is that the components of the complete starting unit are practically identical in the different forms of starter, and for widely varying currents and pressures. A further advantage incidental to the design lies in the fact that no spring return is necessary. Instead, the arrangement of the gear is such that once the starting operation has been commenced, it must be completed, or the circuit-breaker will be tripped. The latter can only be reset after a return to "off."

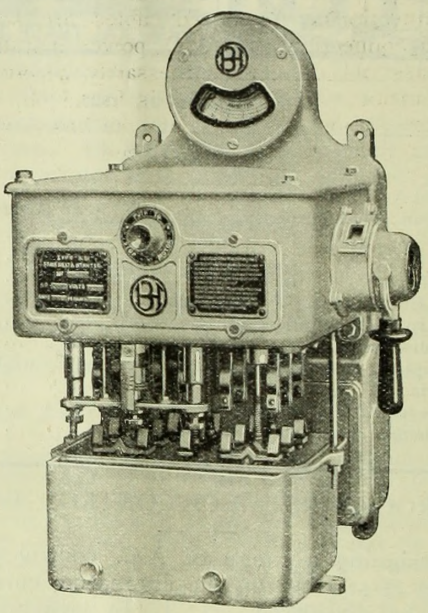


FIG. 5.

The circuit-breaker is provided with "no-volt" release, and with either two or three overload trips as required. These are free to operate either during starting or running, and independently of the position of the ratchet handle.

One of the most important constructional features of the gears is the hollow assembly case used in the pillar type. Complete oil-immersed motor-control gears consist necessarily of a number of separate self-contained components. The satisfactory assembly of these components, to apply the "single iron-clad unit" principle, presents considerable difficulties, not the least important of which is the question of inter-connections. It will be recognised by reference to the illustrations that these difficulties have been entirely overcome by the adoption in the pillar type gears of the Brookhirst patent assembly case. This consists of a hollow steel frame upon which the various ironclad components are mounted and through which are taken in perfect security the requisite inter-connections. The arrangement furnishes a totally enclosed ironclad pillar of exceptionally robust form, comparable in every way with Brookhirst D.C. pillars. The hollow assembly frame being provided with removable back doors, it follows that the inter-connections are particularly accessible.

The construction described above has facilitated the inclusion of another characteristic "Brookhirst" feature. "Safety first" is obtained by the provision, where required, of an isolating switch in the cast-iron base of the pillar, the handle of the switch operating in conjunction with a Brookhirst patent gate interlock, to give the following results. Unless the isolator is "off," the gate cannot be opened, and the covers of the starter and resistance or transformer cannot be

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removed or the oil tank of the starting unit lowered. Conversely, the isolator cannot be operated until the "gate" is first closed. The isolator is of the air-break type, but it is provided that the oil-immersed circuit-breaker is automatically opened before the isolator.

Finally, mention must be made of the accommodation for connections. Armoured cables are so frequently used in connection with A.C. power installations that this class of conductor necessarily receives the first consideration. In practice it is found objectionable to introduce armoured cables into the bases of pillar type gears, owing to the large "bend" or "sweep" the cable requires. The hollow assembly frame again opens the way to a perfectly sound arrangement. Split connection boxes have been standardised on these A.C. pillars, fixed at the sides of the assembly frame at a convenient height to permit the cables to enter either from above or below. From these boxes rigid copper connections are run, inside the hollow frame, to the control switches, and then from the latter to a second connection box or second set of cable terminals for the motor leads. Although the connection boxes are designed primarily for armoured and lead-covered cables, they are suitable for the accommodation of any cable system which may be employed.

Brookhirst Switchgear, Ltd., have a London office at Australia House, Strand, W.C.2, where, in a well-appointed showroom, the foregoing, as well as Brookhirst D.C. starters, etc., may be inspected and tested.

THE LINTON LOCK HYDRO-ELECTRIC STATION OF THE CITY OF YORK.

There are several points of interest in the new hydro-electric power station of the York Corporation. There is a bend in the River Ouse at the Linton Lock, about 11½ miles from York, which facilitates the arrangement of the weir and of the power-station building. The difference in water levels varies from 1 ft. 4 in. to 11 ft. 4 in., giving an average fall during the year of 8.83 feet.

The Ouse, like most rivers without natural compensation, has a very variable discharge, varying, roughly speaking, from 50,000 cubic feet per min. in the dry periods to 200,000 cubic feet per min. in the wet months. Taking 100,000 cubic feet per min. as an average with 8.83 feet head, 1,200 h.p. could be expected from the station. A close calculation showed that the available energy, in normal years, would exceed 2,750,000 kw.-hours per annum.

In order to concentrate supervision and responsibility and to make the co-ordination of work easier, the Corporation, in issuing their specifications, decided to include the civil works, the buildings, and the supply of plant in one comprehensive contract, which was eventually awarded to the English Electric Co., Ltd., who designed and erected the complete power station.

Water is led to the forebay by means of a weir put across the river. It had been agreed with the riverside owners that the water level due to this weir was not to exceed 2 ft. 9 in. above the existing sill; on the other hand, the Corporation wanted to use as much as possible of the available waterfall. To satisfy these two requirements the contractors suggested, and it was agreed, that two automatic weir shutters should be supplied. As will be seen from Fig. 1, the automatic operation of this apparatus is brought about by the variable moment of a counterweight balancing the weight of the water acting on the shutter. Owing to the very small difference in levels which can occur during times of flood (1 ft. 4 in.), special arrangements had to be made in order to prevent the weir shutters rising under the heavier action of the counterweight when the shutter is immersed. This danger was removed by making the counterweight of pumice-stone

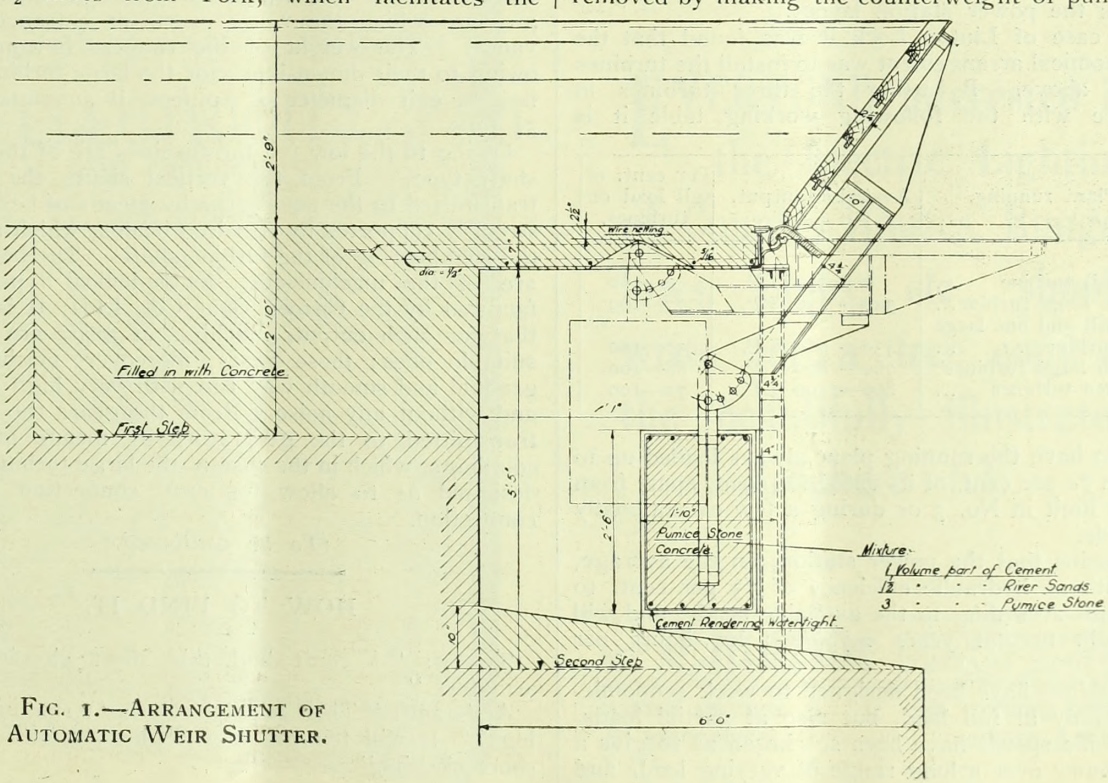


FIG. 1.—ARRANGEMENT OF AUTOMATIC WEIR SHUTTER.

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concrete of 1.5 specific gravity; thus in the case of high water levels in the tail race, its weight is considerably reduced and the shutter cannot rise inopportunely. The automatic weir shutters were supplied by the Société des Barrages Automatiques, of Zurich, Switzerland.

On the left of the weir the water goes into the forebay, passes a strainer rack made of 3 in. by $\frac{3}{8}$ in. wrought-iron bars spaced 2 in. apart, flows under the sluice gates and enters the power station, which is built on very friable soil of a silty nature, some 70 feet deep. Special piling work was necessary in order to ensure safe foundations, and no fewer than 110 piles had to be driven. Precautions in the shape of retaining walls, stone paving, etc., had also to be taken to protect the river banks against floods.

Architecturally the building is very simple, the primary feature of its design being suitability for its purpose. The lighting is from the roof, as the walls had to be watertight to a fair height owing to the high flood levels in the head race, and the crane runway prevents free windows higher up. There are three turbines, two large ones of 430 h.p. each, running at 60 r.p.m. and driving a 540 kw. generator, and one small one, of 330 h.p., running at 75 r.p.m., and driving a 210 kw. generator.

The choice of the number and of the size of these turbines was the result of a thorough study of the conditions. The efficiency of water turbines under low heads drops rapidly when they are used below 50 per cent. of their rated output, so that in order to obtain the best efficiency it is necessary to run them, as far as possible, between half and full load. Consequently, when only small quantities of water are available it is most economical to use turbines of correspondingly small full load output. On the other hand, the larger a turbine the better is its efficiency and, moreover, from the economical point of view, the larger the sets the cheaper is the power station layout.

In the case of Linton Lock it was found that the most economical arrangement was to install the turbines described above. By using the three turbines in accordance with the following working table it is

No.	Plant running.	Available output.	Per cent. of full load on turbines.
1	Small turbine ...	0— 330 H.P.	0—100
2	One large turbine...	330— 430 H.P.	77—100
3	Small and one large turbine	430— 760 H.P.	57—100
4	Two large turbines	760— 860 H.P.	88—100
5	Three turbines ...	860—1190 H.P.	72—100

possible to have the running plant always loaded up to more than 72 per cent. of its rated full load, apart from the lower limit in No. 3 or during a few exceptionally dry periods.

This means that the power station, on the average, works with an hydraulic efficiency of 75 per cent. to 83 per cent. according to the available heads, and will generate in normal years 2,780,000 kw.-hours per annum.

The turbines have been designed to work economically, not only at full load, but also at partial loads. Their specific speeds have been so chosen as to give a high efficiency over a long range of varying loads and heads. Under a normal head of 8.83 ft. the specific speed of the large turbine is 82 and of the small turbine 89.5.

In order to improve the efficiency of the plant and at the same time to reduce the size of the building, the turbines are fed through concrete spirals. These lead the water to the gate apparatus in a better way than ordinary pits, and by allowing a higher water velocity show a gain in space. Moreover, as the turbines are in closed chambers they could be designed with the whole of their governing gear out of the water and easily accessible.

This arrangement also allows the turbines to be situated higher, thus securing a good exit for the draught tube without undue excavation, even in cases where the fall is small, as in this case. At the same time the floor level can be put at any convenient height; in this case, with a view to reducing the necessary volume of concrete and the length of the turbine shafts, it has been chosen level with the average water level in the forebay, and will be below the forebay in time of floods.

From the spiral chamber the water comes into the gate apparatus, which consists of twenty guide vanes 43.3 in. high for the large turbines and 35.5 in. high for the small one. These guide vanes are of cast iron, and are pivoted in bronze bushes carried by the foundation rings; they are operated from above by a system of levers and linkwork. The massive foundation rings of cast iron are connected by steel pillars and built into the concrete, thus forming a good and rigid assembly. This gear was built at the Willans Works (Rugby) of the English Electric Co.

The runners were carefully designed in order to reduce the vertical axial thrust, and have balancing holes and extended cover. Owing to these balancing holes, the space between the runner and the cover is under suction, and the extended cover balances the pressure which the water exerts at entrance on the vanes. The weight of the runners is considerable owing to their dimensions; for the large turbine, which has an exit diameter of 10 feet, it amounts to over $5\frac{1}{2}$ tons.

Owing to the low fall the turbines are of the vertical shaft type. From the vertical shafts the drive is transmitted to the generators by means of bevel gears, strongly supported by cast-iron beams, which also bear the step bearing of the turbine shafts. The bevel gears are of the machine-cut, double-helical type, manufactured by the Citroen Gear Co., Ltd. It is obvious that for such outputs machine-cut gears are the only suitable ones; these gears, moreover, meshing in a gradual and smooth way run with very high efficiency and without any noise. From the gears the power is transmitted to the generators by means of flexible couplings, which in the case of the large turbines are so designed as to allow for easy connection and disconnection.

(To be continued.)

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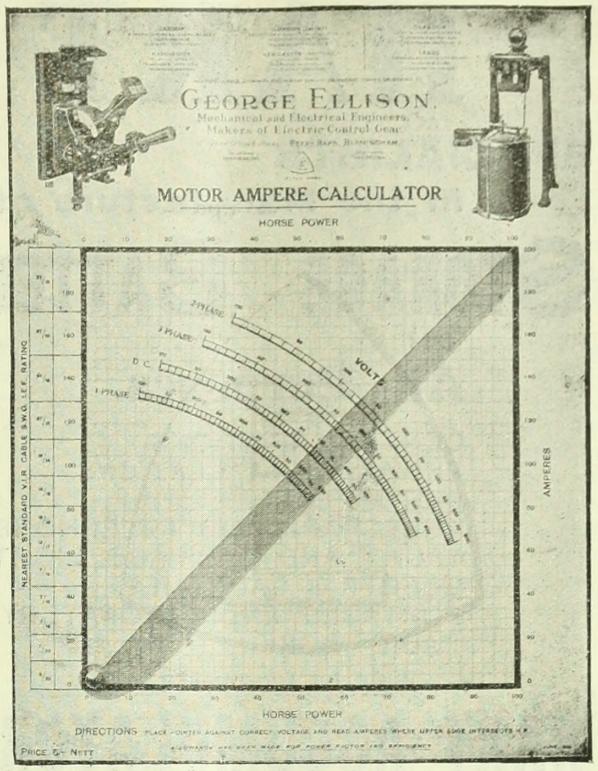
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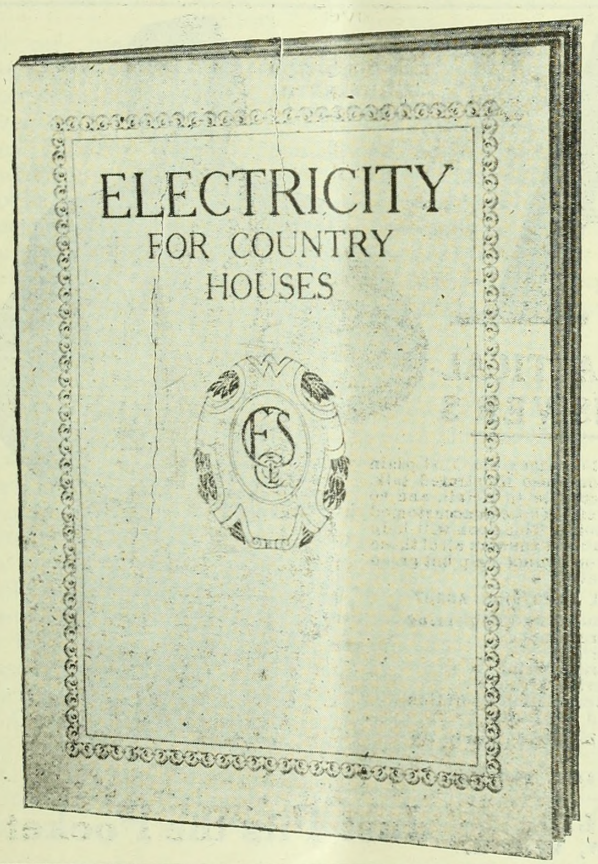
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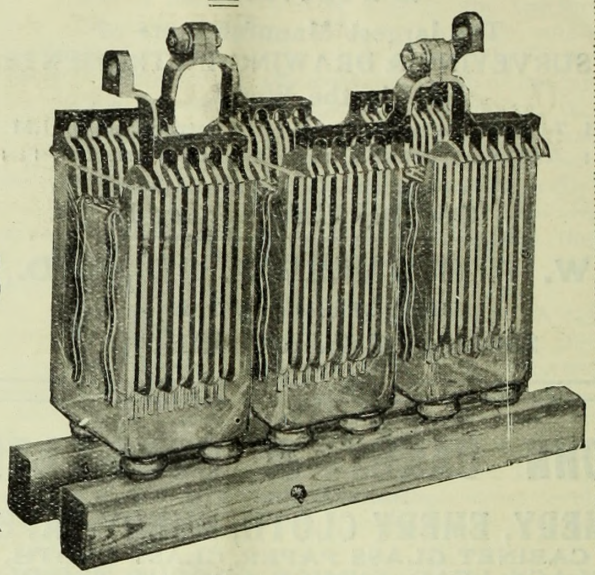
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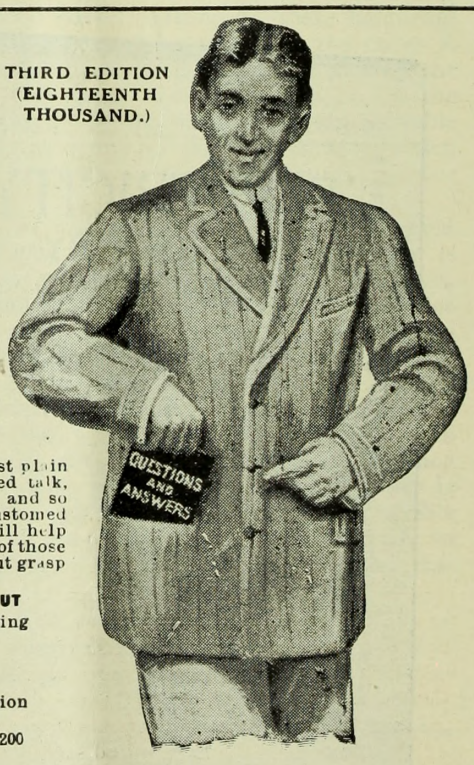
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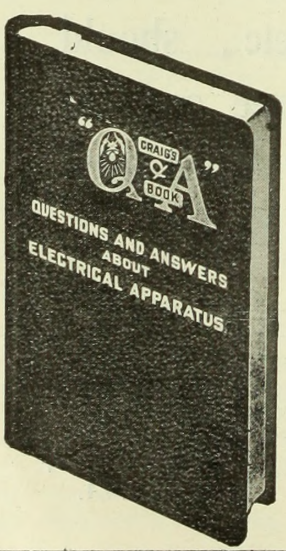
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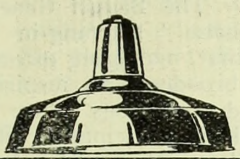
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ELECTRICITY is published every Friday, and, if ordered, is on sale at the principal Railway Station Bookstalls and Newsagents on that day. It has a very large sale throughout the United Kingdom, as well as in the British Colonies and Abroad.

New advertisements for the displayed columns and alterations to existing ones must reach the publishing office not later than first post Tuesday morning, in order to be in time for the issue of the following Friday. This is important. Rate quoted on application. Subscription : 13s. a year, 6s. 6d. half-year, 3s. 3d. a quarter in advance, postage prepaid in the United Kingdom and abroad.

Questions to which an answer is required must be accompanied by a 1½d. stamp for reply. When considered of sufficient interest, the answer will probably appear in the paper.

All remittances payable to the Publishers, S. RENTELL AND CO., LTD., 36-39, Maiden Lane, London W.C. 2. Telephone No. 2460 Gerrard.

Current Topics.

Congratulations to the respective Corporations of Leeds and Bradford upon the common decision to place important contracts for electrical plant with British firms, in the face of lower tenders from foreign competitors. I referred to this subject in my notes in the issue of ELECTRICITY dated September 7, and advanced cogent reasons why such contracts should invariably be placed in this country, even at the apparent loss of a few thousands on the deal. Every thousand pounds spent on finding employment for British labour represents another nail in the coffin of the dole system which we all desire to see decently buried. It is a terribly demoralising influence on the industrial population of this country, and it is refreshing to note that municipal bodies with large orders to place are beginning to appreciate the fact and act accordingly.

The Broad View.

Another town council deserving of commendation under the same head is that of Grimsby. The local Corporation Electricity Committee of the fish metropolis, in considering tenders for new turbines, alternators and condensing plant for works extension, have decided to reject offers from foreign firms. A British firm was also crossed out of the list of "possibles" on account of the absence of its name from the King's Roll in connection with the employment of ex-Service men. Here again we have an excellent precedent even in the final selection of British tenders. Among the vast army of unemployed there are still a large proportion of those gallant lads who faced all the dangers and discomforts of the trenches for at least part, if not the whole, of the prolonged struggle, and it should be our first duty to see that every deserving ex-Service man has first claim to a job when one is going. Memories are proverbially short, and although the majority of us want to forget the Great War and its horrors, we should not include the survivors in that endeavour, but always bear in mind what they did for the Empire.

A project is afoot for constructing an electric railway in the Lake district between Windermere and Keswick, starting about half a mile on the Kendal side of Windermere village. The strong opposition which previous proposals of this character have had to face seems now to be lessening on account of the increase in motor traffic and the danger to pedestrians on the lakeland roads. As an old motorist, with experience of the beauties and attractions of the Lake district, I heartily endorse the proposal to render this area more accessible to tourists by means of an electric railway system. Nature lovers without experience of the possibilities of electric traction will probably deplore the imagined vandalism which suggests the introduction of such a practical scheme. To these critics I would commend a tour of the Manx Electric Railway system which extends between Douglas and Ramsey, and gives access to many of the Island's beauty spots without in the least detracting from their natural charms.

Lakeland Electric Railway.

On this railway, which is equipped on the overhead trolley system, the cars resemble single-deck tramcars, the seats being arranged transversely and accommodating four adults without crowding. With normally open sides and covered tops, the entire countryside is open to view, and the trains pass through some beautiful scenery, both along the coast line and inland. There are several stiff grades to be negotiated, similar to those likely to be met in Lakeland, and, should the weather prove inclement, revolving shutters can be drawn down on either side, according to the direction of the wind and weather, making all cosy within and giving the equivalent of a completely closed coach. The ticket system is in keeping with the routes, passengers being at liberty to break their journey at any point which appeals to them. The tickets are snipped at frequent stages, marking the completion of that stag I should imagine that a similar system would prove a complete success in Lakeland, and at the same time relieve the existing narrow thoroughfares of much of the road congestion due to charabancs and larger hired cars, the only available means of touring the district at present.

At a recent meeting of the Newcastle Chamber of Commerce, Mr. Charles Turnbull, borough electrical engineer, Tynemouth, said that it was not generally realised how America was getting hold of our markets to-day. All kinds of goods had to be ordered from America which could very well be manufactured in this country, such as electrical meat-cutting machines and mechanical devices of all sorts. Briefly, the reason was that the British Government did not encourage inventors. In America a patent could be taken out for seventeen years at a cost of only £7. In Great Britain no less a sum than £131 had to be paid for a lesser term of sixteen years. The result was that many Englishmen with good ideas were financially unable to carry them out. If the Government devoted the same attention to patents as they

Dear British Patents.

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had recently devoted to betting, for instance, the nation would derive considerable benefit. If they did not do so the States would continue to deprive us of a great deal more of our trade in patented articles.

There is a good deal of truth in this indictment; many promising inventors are comparatively poor men, unable to find the money to exploit their ideas. The result is that many ingenious novelties are either allowed to languish for lack of funds, or find their way into the possession of powerful financial groups which all too often take an unfair advantage of the original inventor's poverty and ignorance, and reap the harvest of his brain without allowing him an adequate share in the proceeds. The inventor with a fertile brain who has thus been once bitten becomes more than twice shy, and it is odds-on that having passed through such an experience in regard to the first creation of his genius he becomes discouraged, and no matter what his subsequent productions may be in the novelty line, arrives at the conclusion that the game is not worth while and resolves to take no further steps in the matter of placing them upon the market. The cheaper we can make protection for the genuine inventor, the better for our future commercial supremacy.

A Healthy Sign.

The generation of electricity in Great Britain for the year ending March 31 last is dealt with by the Electricity Commissioners in a recent publication. Returns were received in respect of 532 power stations, and, as compared with the previous year, the total output showed an increase of 854,000,000 units, or 17.5 per cent., whereas the total consumption of fuel showed an increase of 203,637 tons, or only 3 per cent. The average consumption of fuel at steam stations was reduced from 3.11 lb. to 2.78 lb. per unit generated, a saving of 10.6 per cent., and at oil stations from 2.08 lb. to 1.72 lb. per unit generated, or a saving of 17.3 per cent. The average fuel consumption at gas-producer stations, however, showed an increase from 2.64 lb. to 2.70 lb. per unit generated. The general trend of the report is both towards increasing electrical development and increased economy of generation, facts which augur well for the future of the electrical industry as a whole.

ELEKTRON.

WIRELESS BROADCASTING FOR AUSTRALIA.

The wireless convention recently called to prepare regulations covering broadcasting in Australia has placed a recommendation before the P.M.G. of the Commonwealth of Australia for approval. We shall, therefore, hear shortly of the final regulations adopted, and a broadcasting service will no doubt follow at an early date.

The possibilities of broadcasting in Australia are enormous, as a large proportion of the people live far away from the centres of population and would, therefore, greatly welcome a service which would bring brightness and amusement to them. Still more important is the value of wireless to the farmers, and there is no doubt that a regular service of weather reports and other agricultural information would be of the greatest possible service.

In order to demonstrate the possibilities of broadcasting some interesting experiments were carried out on the occasion of the recent State Conference at Hawkesbury College, Sydney, N.S.W. At the invitation of Sir Joseph Carruthers, the president of the N.S.W. Chamber of Agriculture, the Amalgamated Wireless Australia, Ltd., transmitted a complete musical programme, the acting Premier of the States and other officials speaking a few words. The receiving end was organised by The British General Electric Co., Ltd., a "Gecophone" listening-in set being installed. Mr. Edward Hirst, managing director of The British G.E.C., Ltd., broadcast an inspiring message predicting a bright and prosperous future for broadcasting in Australia, and, in anticipation of a regular service, a "Gecophone" receiving set has been installed at the Hawkesbury College, where no doubt some tuition in wireless will form part of the curriculum.

Answers to Correspondents.

J. R. WOODHATCH.—From the nature of your question we gather that you have a three-wire supply, 200 volts across outers and 100 volts between outers and neutral. In this case you cannot obtain 300 volts by connecting them together. We have placed your other questions for competitive replies in our Questions and Answers Competition. In this way you will have the benefit of the experience of our readers.—Editor, ELECTRICITY.

THE TIVOLI CINEMA.

The new Tivoli Cinema in the Strand, opened on the 6th inst., is certainly a handsome building, the exterior being treated in a dignified classic style and the interior richly decorated in Empire style.

Turning now to the lighting scheme, this was designed by the Illuminating Engineering Department of the G.E.C. in conjunction with the architect, Mr. Bertie Crewe. The whole of the electrical installation work was entrusted to the Berkeley Electrical Engineering Co.

The exterior of the building facing the Strand is flood-lighted by 24 G.E.C. floodlights, 12 equipped

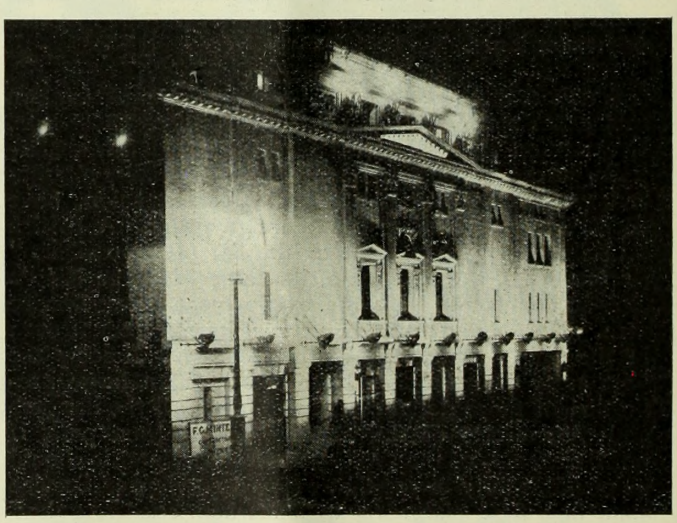


FIG. 1.

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with 500-watt Osram gasfilled lamps, and 12 with 200-watt lamps. These are mounted on ornamental bronze brackets and hidden by bronze screens, which form an attractive feature of the frontage. The photograph reproduced in Fig. 1 is a night view taken solely by the light of the floodlighting installation, and shows the brilliant effect produced.

Inside the building, interest naturally centres round the auditorium lighting. The novelty of the installation lies in the fact that practically the whole of the lamps are concealed.

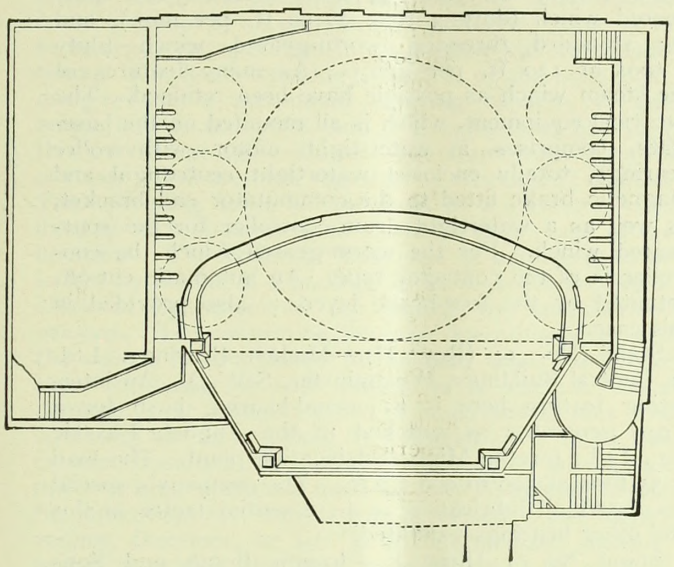


FIG. 2.

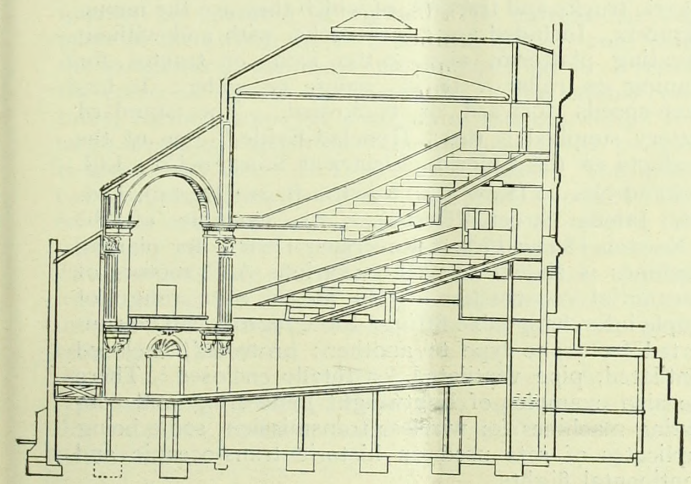


FIG. 3.

As far as the auditorium is concerned, there is a total absence of fittings projecting from ceiling or walls, even the police lighting, except the exit signs, being included in the indirect lighting scheme.

The main illumination is derived from the domed ceiling. As will be seen from the ceiling plan and sectional view reproduced in Figs. 2 and 3, the ceiling consists of one large shallow dome 54 ft. in diameter and six subsidiary domes 16 ft. in diameter. Hidden within a moulded cornice around the circumference of each dome is a row of Osram lamps in specially designed reflectors. These are arranged in three circuits and are coloured amber, blue and rose respectively. Each circuit is controlled by a dimmer, and the switching is so arranged that the colours may be used independently or may be blended together to obtain colour effects. A photograph of the ceiling is reproduced in Fig. 4.

Under the gallery and balcony the lighting is supplemented by a number of ceiling panels, arranged to reproduce the same colour effects as the main ceiling lights.

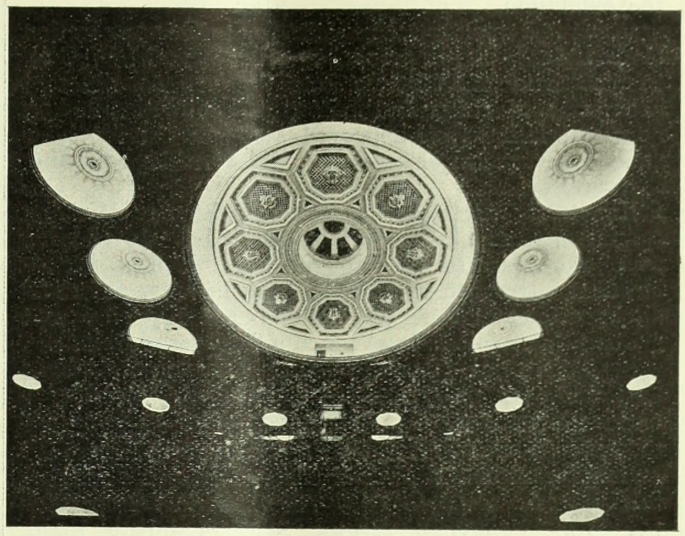


FIG. 4.

Additional illumination is obtained in various parts of the house by amber-coloured panels let into the walls. A number of G.E.C. projectors with colour-sprayed Osram gasfilled lamps are also sunk flush in the front of the gallery to illuminate the proscenium arch.

THE SHIPPING, ENGINEERING AND MACHINERY EXHIBITION AT OLYMPIA.

(*Continued from page* 496.)

MAIN HALL.

Stand No. 5 (Row F).—Ransomes, Sims and Jefferies, Ltd. (Orwell Works, Ipswich). A 15-cwt. model of the patent electric runabout crane (previously fully described in these pages) is among the exhibits made by this well-known firm. The battery of accumulators carried on the truck enable it to turn, hoist and derrick, as well as turn about its own centre like a turntable, under its own power. It can be used on moderately uneven ground, and can negotiate and operate on a gradient of 1 in 10. Of the two models of "Orwell" electric industrial trucks shown, one has an elevating platform and the other has four-wheel steering, a feature rendering it most useful where narrow passages and sharp corners have to be negotiated.

Stand No. 10 (Row F).—Boulton and Paul, Ltd. (Riverside Works, Norwich). There are two specially interesting exhibits to be seen on this stand. One is the "Electolite" semi-automatic, self-contained lighting plant, of 1.5 kw. capacity, at 32, 50 or 100 volts. The engine has a patented vaporiser,

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which changes over from petrol for starting to paraffin automatically. The switchboard, of the drum-controller type, is constructed entirely of metal and mica. Automatic lubrication is provided, and by means of a patented device the engine is automatically shut down should the oil supply give out. The other appliance referred to is the Boulton water elevator. In this, water is efficiently raised by means of a multi-cellular endless band from depths of 306 ft., while quantities up to 20,000 gallons per hour can be dealt with. An elevator is in operation in a 40 ft. tower in the exhibition.

Stand No. 17 (Row F).—The Radio Communication Co., Ltd. (34/5, Norfolk Street, Strand, W.C.2), besides various wireless sets for use on different categories of ships and boats, and direction-finding apparatus, show their approved " Polar B " radiophone cabinet set, and a selection of high-class broadcasting accessories.

Stand No. 18 (Row F).—The British Arc Welding Co., Ltd. (Gengall Road, Millwall, E.14). In addition to photographs of welding repairs, this firm demonstrate the strength of various welded joints, and show an experimental tank with welded and riveted seams made to instructions from Lloyd's Register of Shipping.

Stand No. 22 (Row F).—The Reliance Telephone Co., Ltd. (12/13, Henrietta Street, W.C.2), display various telephone, signalling and alarm systems for industrial and commercial use, also a small W.E. automatic exchange.

Stand No. 3 (Row G).—The Electrical Apparatus Co., Ltd. (Vauxhall Works, South Lambeth Road, S.W.8), make a representative display of their many designs of motor control gear, house service meters, voltmeters and ammeters. The house service meters shown include the new type E, in which replacement or renewal of any part is a simple operation, the design being such as to ensure accuracy and facilitate adjustment, also repair when necessary.

Stand No. 7 (Row G).—The Quasi-Arc Co., Ltd. (15, Grosvenor Gardens, S.W.1), show various test-pieces and samples of Quasi-Arc welded work. The Quasi-Arc process of electric welding for iron and steel is used in the Royal dockyards, in a large number of industrial establishments, and for welding (instead of riveting) ships. Gasholders up to three million cubic feet capacity have been welded by the process, a feature of which is the blue asbestos coated electrodes used. The process is fully described in the *Practical Electrician's Pocket Book for 1923*. The firm's 60/30 volt complete welding set is also to be seen on the stand.

Stand No. 8 (Row G).—Edison Accumulators, Ltd. (Associated with Nobel Industries, Ltd.), of 15, Upper George Street, Edgware Road, W.1, are showing their " all-steel " accumulators, which are available for all purposes where a secondary battery is required.

Stand No. 14 (Row G).—British Electric Vehicles, Ltd. (Churchtown Works, Southport), as examples of their products, here show a 5,000 lb. capacity electric truck for docks or works transport, and a $2\frac{3}{4}$-ton battery type loco. for use in docks, mines, etc., or by contractors.

Stand No. 13 (Row G).—The Electro-Mechanical Brake Co., Ltd. (Eagle Works, West Bromwich). E.M.B. unbreakable, jointless and rustless grid resistances, as used throughout the world, are displayed on this stand, where are also to be seen various E.M.B. steel case controllers for steel works, shipyards, and collieries, for cranes and haulages, etc. Also for trolley buses, battery vehicles, ship winches, etc. The various working parts of these controllers are readily accessible, while the current-carrying parts are amply proportioned to allow of large overload capacity, and the mechanical design is thoroughly robust.

Stand No. 6 (Row H).—Harfield and Co., Ltd. (Blaydon-on-Tyne). This firm, in conjunction with the Metropolitan Vickers Electrical Co., Ltd., have developed a range of electrical cargo winches in various sizes. They are showing the standard 3-ton spur-geared winch (duty 3 tons at 90 ft. per min.), and the standard three-ton worm-geared winch (duty 3 tons at 120 ft. per min.). As many features of the steam winch as possible have been retained. The electrical equipment, which is all mounted on the base-plate, comprises a water-tight motor with roller bearings, totally enclosed watertight centrifugal and magnetic brake fitted to the commutator end bracket, as well as a watertight drum controller for the spur-geared winch. For the worm-geared winch the controller is of the contactor type. An automatic cut-off, actuated by the foot-brake lever, is also provided in this case.

Stand No. 14 (Row H).—Michell Bearings, Ltd. (3, Central Buildings, Westminster, S.W.1). An interesting feature here is a journal-bearing bush for a large generator as supplied to the English Electric Co., Ltd., for the Midi electrification plant. The load is 35 tons at 500 to 900 r.p.m. The company's special circulated oil lubrication is an essential factor in this and other bearings exhibited.

Stand No. 1 (Row J).—Joseph Booth and Sons (Rodley, Leeds) show various " Union " industrial electric trucks and tractors, of which they are the manufacturers. Included are 2-ton trucks, with and without elevating platform, also 10-ton loco. or tractor for running on rails of 18 in. gauge or wider. It has three-speeds forward or backward. The standard battery supplied is the " Ironclad-Exide," one of the products of the Chloride Electrical Storage Co., Ltd.

Stand No. 10 (Row J).—Newton Bros. (Derby), Ltd. (St. James Street, Derby). An example of the " Newton Derby Patent Reversing Gear " for planing machines is shown as well as various A.C. motors of substantial construction. By means of a range of simple interchangeable fittings these motors can be converted from one type to another: protected, enclosed ventilated, pipe ventilated, or totally enclosed. There are also examples of lightweight generating and converting machines for wireless transmission, some being duplicates of sets used on historic trans-oceanic and Continental flights.

Stand No. 14 (Row J).—Sprecher and Schuh Co. (Aarau, Switzerland, and 212a, Shaftesbury Avenue, W.C.2). A prominent feature of this stand is the mast transformer cabin, completely equipped and mounted on two transmission line poles, the line being stretched right across the stand to terminate at the other end in a line sectioning switch also mounted on the top of a pole. The transformer cabin is of sheet iron and the transformer, which need not necessarily be of the outdoor type, protruded through the base of the cabin so that the terminals are protected against atmospheric influences. The H.T. line terminates on the top of the cabin in suitable H.T. bushings consisting of a porcelain insulator through which the connect-

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ing bolt leads the current to the interior of the cabin. The primary side of the transformer is protected by three H.T. expulsion type fuses. The secondary side of the transformer as well as the distribution lines are equipped with porcelain handle type fuses, and the L.T. leads are taken out of the cabin through suitable porcelain pipes. Doors are provided at either side of the cabin to give access to the interior, and a folding platform with safety rail enables the operator to attend to his duties without danger. Above the cabin lightning arresters are fitted. These consist of horn type spark-gaps in combination with earthing resistances. The latter are preferably made of carborundum rods contained in an earthenware protecting tube so as to be ready for operation in all possible climatic conditions. The line sectioning switch is of the horn type, designed for a permanent carrying capacity of 200 amps. and 12,000 volts, and it is capable of breaking this current at full voltage. The framework consists of tubes which are built together by mechanical clamps. The operating lever is contained in a cast-iron case fixed at such distance as to be within easy reach of the operator. The cover of this case is arranged to be locked by means of a padlock so as to avoid the possibility of operation of the switch by unauthorised persons. The connection between operating lever and the switch is established by an iron tube, the whole therefore being of such design as to exclude wilful damage. It should also be mentioned that the operating handle is locked by a hinged cover in its two extreme positions "on" and "off," which means that the switching operation must be fully completed before the operating machanism can be closed. The switch cannot, therefore, be left in an intermediate position, and it is evident that this arrangement is of greatest importance considering that these switches may frequently be operated at night. The current-carrying parts of the switch are of brass and copper, and, with the exception of the horns, nickel plated so as to resist the corrosive effects of the weather. The exhibit contains, further, some oil switches of modern design for large breaking capacities. One of these switch groups is fitted with direct H.T. overload release. The other two groups are fitted with electrical remote control. The oil tanks are made with curved sides so as to give the necessary resistive strength against internal pressures. The contacts are designed to guard against jolting when closing the switch, and porcelain is avoided in the interior of the switch, whereby the risk of breakage is reduced. The stand contains, further, a H.T. feeder panel and a collection of H.T. apparatus such as horn type lightning arresters, choke coils, isolating switches, line supports, fuses and also some L.T. switches and switch fuses.

Stand No. 15 (Row J).—Marconi International Marine Communication Co., Ltd. (Marconi House, Strand), are showing here the latest developments of the Marconi Marine Service :—(1) The Marconi marine direction finder (normal range 100 miles) in conjunction with an aerial consisting of two loops at right angles enables bearings to be taken of any coast station or other ship using its transmitter, with an accuracy within one or two degrees. (2) Receiver for a rotating wireless beam. This apparatus, which is usually called the "Beam Receiver," has only just been developed. The transmitter with which it is associated is installed on land, and projects a wireless signal up to a distance of about 10 miles in a narrow beam, the arc covered being about 20 degrees at full strength, with a 10 degree fringe of about half-strength each side of it. The whole projector is rotated slowly and signals a prearranged morse letter at every two points of the compass. The extremely short wavelength of six metres is used for this purpose, and signals transmitted in this way are entirely free from all kinds of interference. For such short waves, a special receiver is necessary, which is entirely independent of the ship's ordinary wireless installation and does not require operation by a skilled telegraphist. The instrument must be permanently tuned, and all that is required to bring it into operation is to switch on its receiving valves. If the receiver is switched on when the ship is anywhere near the revolving beam transmitter, two of the letters transmitted by the beam will be heard, and the bearing of the transmitter will obviously lie between the two points represented by the letters. These single letters are sent out at a speed equivalent to 12 words per minute, and at this speed they are very easily distinguished after a little training. In order to make it possible to determine the bearings with a greater degree of accuracy, the space between the "long" letters referred to above is divided up by "short" letters such as I or T, which are signalled at each half point. Experience shows that the beam transmitted by a projector of this nature is not liable to distortion, and the method of signalling the bearing is independent of the rate of rotation of the projector. There is one completed projector operating on the Island of Inchkeith in the Firth of Forth, and a second is being constructed close to the South Foreland Lighthouse. (3) Installation for ships' lifeboats. Arranged for the 26-ft. class A open lifeboat, the whole apparatus can be placed complete between the two after thwarts of this boat. In the 28-ft. lifeboat it can be similarly arranged beween the upper and above the lower thwarts. The compartment contains a $\frac{1}{4}$ kw. transmitter with a small petrol engine and alternator. The aerial is a single rather stout wire supported by light spars which can be shipped in sockets attached to the stem and to the stern post of the boat. The whole arrangement is so light that these spars will stand without rigging and can easily be erected when the boat is in the water. The range of communication which can be established with an ordinary ship working on a wavelength of 600 metres is not less than 50 miles. The receiver is of a special type embodying the principle of a direction finder. (4) The Duplex telephone set, as now under trial in co-operation with the G.P.O. at Southampton. Its purpose is to put ships within short distance of land in telephonic touch with offices. The sea distance which can be covered by this installation is about 50 miles.

(To be concluded.)

Radio Research Board Report.—Special Report No. 1, entitled "A Discussion of the Practical Systems of Direction-finding by Reception," by R. L. Smith-Rose, Ph.D., M.Sc., and R. H. Barfield, M.Sc., Royal 8vo, paper wrapper, pp. iv.+27, with 10 text figs. and one plate, has just been issued by the Radio Research Board, and may be obtained from H.M. Stationery Office or from ELECTRICITY Office, price 10d. post free. It describes investigations which have been carried out on behalf of the Directional Wireless Committee of the Board, chiefly at the Board's station at the Admiralty Compass Observatory, Ditton Park, and should interest many wireless readers.

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Questions and Answers by Practical Men.

RULES.

QUESTIONS : *We invite our readers to send us questions, preferably on technical problems that have arisen in actual practice. Questions which we consider of sufficient interest to our readers will either be replied to under "Answers to Correspondents" or replies will be invited from our readers. One shilling will be paid for the question which we select for competitive replies in this column.*

ANSWERS : *A fee of 10s. will be paid for the answer which we consider shows the greatest merit, and 5s. for the one we select as second best. In judging the replies, importance will be attached to clearness and conciseness, as well as accuracy. The Editor reserves the right to make no award, or to accept only one reply, if, in his opinion, the answers received do not possess sufficient merit. Competitors desiring the return of their manuscripts, if unaccepted, should enclose stamped addressed envelope.*

Write on one side of the paper only, and if diagrams are sent, draw them on a separate sheet of paper attached to the manuscript. Competitors may adopt a "nom de plume," but, both in the case of questions and answers, the competitor's real name and address must be sent with the manuscript as a guarantee of good faith. No correspondence will be entered into with regard to successful replies. The Editor's decision is final.

Commencing with Question No. 101, a Diploma of Merit will be awarded to the six competitors who win the first or second prize the most times during the next twelve months.

The words "Questions and Answers" or "Q" and "A" should be placed at the top left-hand corner of all letters intended for this column.

QUESTION NO. 167.

I have a large bell in my works used to signal the "commence work" and "cease work" to my employees. At present it is operated by hand. Can I electrify this so that it will work if I press a button? If so, I would appreciate the details.—"CASHIER."

QUESTION NO. 168.

I wish to convert a 220 volt D.C. motor to one of 100 volts. The machine is 4-pole, wave wound, 10 b.h.p., 750 r.p.m. Can you give me the full details to enable me to carry this conversion out?—"WINDER."

(Replies to Questions Nos. 167 and 168 must be received not later than September 29, 1923.)

Various Items.

Personal.—Sir Charles Bright, F.R.S.E., wishes it to be understood that he has withdrawn from the Board of Sir Charles Bright and Partners, Ltd. The company is at present retaining the name in its title, but Sir Charles himself is no longer associated with its activities, and temporarily his only business address is 25, Victoria Street, Westminster. Telephone No. Victoria 650.

Plant Wanted.—The Copenhagen Municipality invite tenders for one electric crane for unloading coal from ships at the quay side.——The State Electric Light Works at Montevideo want 24,750 fuse fittings, amongst which are included 3,000 distributing fuses with bipolar or tripolar fuses for normal Edison screw plugs. Specification, etc., at the D.O.T. (Room 52), 35, Old Queen Street, London, S.W.1.

Forthcoming Books.—Two important books on the ever-popular subject of wireless are announced for publication this month by Messrs. Ernest Benn. The first is a treatise on "The Poulsen Arc Generator," by that eminent authority, Mr. C. F. Elwell, to whom chiefly is the credit due for its practical development. The second is on "The Principles and Practice of Wireless Transmission," by Mr. Parr, and is, like Mr. Elwell's book, the first to be devoted exclusively to its subject.

The Argentine.—The tenth annual report (1922-3) of the British Chamber of Commerce in Argentine Republic (Inc.) is now available, and in it the conditions prevailing are naturally carefully dealt with and are summed up in the statement that although the conditions of depression still exist, they have been, on the whole, less acute in the past year than during the period 1921-2. Competition is very keen in the Buenos Ayres market, and, leaving aside the low purchasing power of the Argentine dollar at the present time, orders are lost to British traders on account of high manufacturers' prices, coupled with high freights. "Price and price only is the dominating factor in the Argentine market; and until the importance of this fact is fully realised any material increase in the present unsatisfactory volume of trade between the U.K. and Argentine cannot be hoped for."

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A POPULAR SCIENTIFIC WEEKLY JOURNAL
ELECTRICITY
A PRACTICAL TRADE JOURNAL

SEPTEMBER 28, 1923.

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IMPORTANCE OF USING LAMPS AT RATED VOLTAGE.

By W. Millner, B.Sc., A.M.I.E.E.
(Lighting Service Department, B.T.-H. Co., Ltd.).

The total cost of light produced by a lighting installation is made up of three factors—the cost of energy consumed, the cost of renewal of lamps, and interest on capital invested in the installation. The latter charge is so small in comparison with the other two that it can be neglected without appreciably affecting the results.

Since the introduction of incandescent electric lamps efficiencies have been enormously improved, the modern gasfilled lamp giving about seven times the amount of light for the same consumption of energy, as compared with the lamps of 1880. This gain in efficiency has had more effect on reduction of the cost of light than all other causes together.

The efficiency of a lamp is governed by the temperature at which the filament is operated, and a very small change in filament temperature has a very great effect on the output of light from the lamp. A reduction of 1 per cent. in the temperature of the filament causes the light output to be reduced by 11 per cent.

The life of a lamp, or the number of hours burning before failure (not counting mechanical breakages), depends entirely upon the efficiency at which the lamp is operated. It has been estimated that, if one of the present 100-watt gasfilled lamps were operated at the efficiency of the lamps of the 'eighties, it would have, if not broken, a life of 47,000 years. During this period the excess of coal consumed in comparison with a present 20-watt lamp, which would have the same light output, would be enough to coal a large battleship for seven trips round the world.

The physicists, to whom this advance is due, have thus played no small part in the conservation of our coal resources.

A large number of people attempt to reduce their lighting bills by installing lamps of a higher rated voltage than the voltage of the circuit to which they are connected. In this way the renewal charge is reduced, but the loss in efficiency is out of all proportion to the saving effected, with the result that the actual cost of the light produced, which is the commodity being paid for, is increased.

The rated average life of present lamps is 1,000 hours, and any attempt to prolong this by running the lamps at a lower efficiency is uneconomical in all cases except where the charge for energy is negligible. This is a happy state which is practically non-existent.

If the change in light output was proportional to the change in voltage, some excuse might be offered for this practice, but a study of the curve in Fig. 1 will show that a 10 per cent. reduction in applied voltage reduces the light output by 32 per cent.

Again, owing to the temperature co-efficient of tungsten, the reduction of current through the lamps

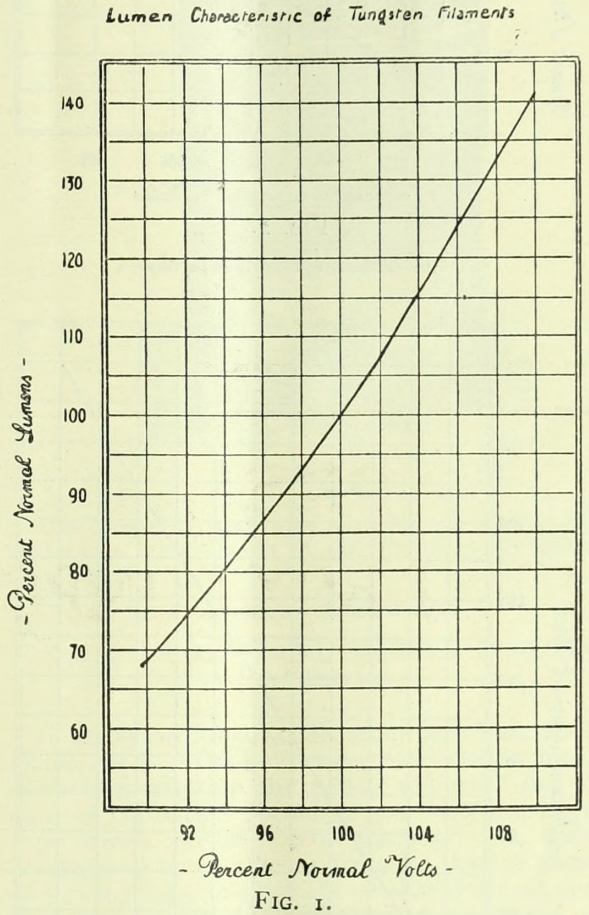


FIG. 1.

is not proportional to the reduction in voltage. This is advantageous in that it makes the lamp, to some extent, self-regulating on fluctuating voltage. The effect of voltage variation in current passing through the filament, and the total energy consumed, is shown in Figs. 2 and 3.

Take a concrete case of a 100-watt 100-volt gasfilled lamp; we find from the makers' lists that the light output is 1,300 lumens, and the list's price is 5s. For 1,000 hours normal life the energy consumed by the lamp at 6d. per unit is 50s. The total cost of supplying 1,300 lumens for 1,000 hours is 50s. plus 5s., or 55s.

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If the same lamps be operated at 10 per cent. below the rated voltage, we find from the curve, Fig. 1, that the light output is reduced to 68 per cent. of the normal, or, instead of obtaining 1,300 lumens from the lamp, we now obtain only 885 lumens.

Reference to the curve showing the relation between wattage and voltage, shows that the reduction of 10 per cent. in voltage causes the lamp to consume only

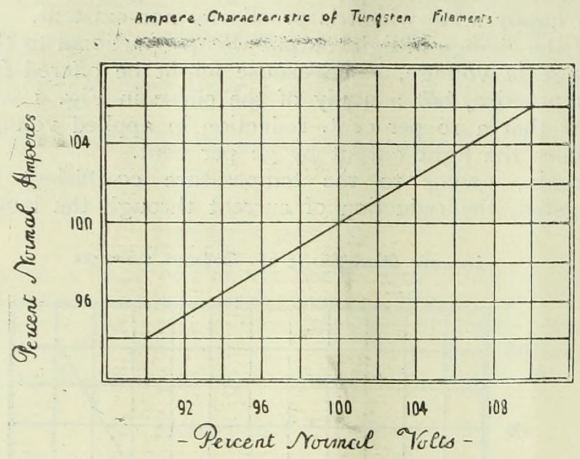


FIG. 2.

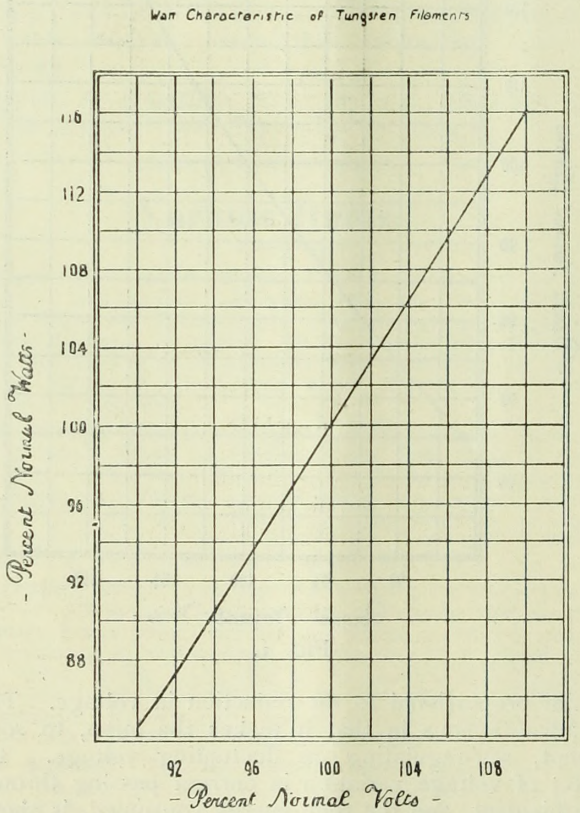


FIG. 3.

$84\frac{1}{2}$ per cent. of its normal consumption; in other words, the nominal 100-watt lamp at 10 per cent. reduced voltage consumes $84\frac{1}{2}$ watts. Therefore, the energy cost of supplying 885 lumens for 1,000 hours is 42s. 3d., and if we assume that by reducing the voltage we have doubled the life of the lamp, which is a generous assumption, as mechanical breakage will probably prevent this figure being reached, the cost for renewal per 1,000 hours is 2s. 6d. Therefore, the total cost of 885 lumens for 1,000 hours is 42s. 3d. plus 2s. 6d., which equals 44s. 9d. At this rate, the cost of 1,300 lumens for 1,000 hours would be 65s. 6d. Thus we see that, instead of saving money by installing lamps of higher rated voltage than the circuit, it actually costs 10s. 6d. more to obtain 1,300 lumens for 1,000 hours. This can, perhaps, be more clearly emphasised by tabulating the items:—

	At Rated Volts.
Output of lamp	1,300 lumens
Consumption of energy	100 watts
Cost of energy per 1,000 hours	50/-
Cost of renewals per 1,000 hours	5/-
Total cost of 1,300 lumens per 1,000 hours	55/-

	At 10 per cent. below rated Volts.
Output of lamp	885 lumens
Consumption of energy	84.5 watts
Cost of energy per 1,000 hours	42/3
Cost of renewals per 1,000 hours	2/6
Total cost of 885 lumens per 1,000 hours	44/9
Cost of 1,300 lumens per 1,000 hours	65/6

Extra cost incurred per 1,300 lumens per 1,000 hours by burning lamp at 10 per cent. below rated volts, equals 10s. 6d.

This figure is the loss for a single lamp. It does not require much imagination to realise that a very considerable sum is involved when a large installation with several hundred points is under consideration.

The economy of a lamp cannot be judged by the number of hours which it will burn, for the above example clearly shows that the efficiency is by far the most important factor affecting the total cost of the light produced. The life of a lamp depends upon the efficiency at which it is operated, and it is impossible to alter one without affecting the other, and the length of life which gives the most economical result in service depends on the cost of current and the price of lamps.

In general, the high cost of energy justifies lamp lives being made shorter, with a consequent gain in efficiency, and any reduction in the price of lamps also calls for higher efficiencies to give the most economical service.

When consumers realise that the commodity for which they are paying is light, and not current or lamps, they will realise that it is not economical to attempt to increase the useful life of a lamp by such means as running it on a circuit voltage lower than the rated voltage of the lamp.

Minute care is taken to ensure that the efficiency transformation of energy in the power house is at the very highest possible efficiency, and it is surely useless to take this care if the final transformation of electrical energy into the form in which it is required, that is, light, is only carried out at a small percentage of the possible efficiency which can be obtained.

The Lanston Monotype Corporation, Ltd. ("S" Dept., 43-4, Fetter Lane, E.C.4), advise us that they would be pleased to send particulars of their "Radbore" Head Square Hole drilling attachment to those applying.

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STOPPING THE DUST.

Winder: "I can't make out how the carbon dust gets at the back of this winding."

Tester: "Well, that is why your work is always bad."

Winder: "What am I to do?"

Tester: "Get 'Armature Winding,' by Sylvester. He can put you up to a wrinkle or two. He has been through the mill, and knows."

NEW ELECTRIC FIRES AND COOKERS.

A STRONG ELEMENT.

Great activity has been shown of late years by designers of electric fires and cooking appliances, not only on account of old-established manufacturers, but of new aspirants for a share of the profitable business available now that the public has been awakened to the real advantages of the electric way of achieving comfort. One of the recent recruits bidding successfully for support is the old firm of Moorwoods, Ltd. (Harleston Iron Works, Sheffield, and Chicheley Street, Belvedere Road, S.E.1), which has added to its coal and oil a range of electric appliances in which a

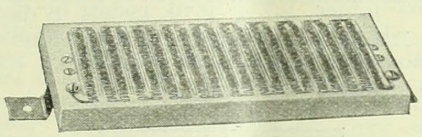


FIG. 1.

patented element (Fig. 1) is used. This is built of extra heavy strip formed into a continuous length of corrugations, whereby a maximum heat radiating surface is obtained. It is securely anchored at intervals to the refractory base. Tests on these elements show great strength, danger of burning out (even under rough treatment) practically nil, quick heating up and cheerful appearance. They are made up in a variety of frames, and the whole fire is mechanically and

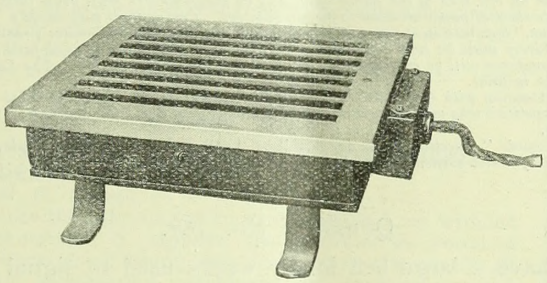


FIG. 2.

electrically sound, as well as being built up so that it can readily be taken to pieces if and when necessary. This element lends itself to use in boiling plates, as the source of the heat can be brought quite close to the top plate on which the utensil is placed. The completed appliance is shown in Fig. 2. It is so designed that the danger of trouble due to liquid boiling over is certainly reduced to a minimum. The firm have just recently, too, turned their attention to the production of a domestic cooker (Fig. 3), and with their accumulated experience of years have turned out what appears to be a thoroughly efficient and serviceable article. An examination shows that little or no fault can be found with the arrangement of the elements as regards control, protection, and accessibility for cleaning or repair.

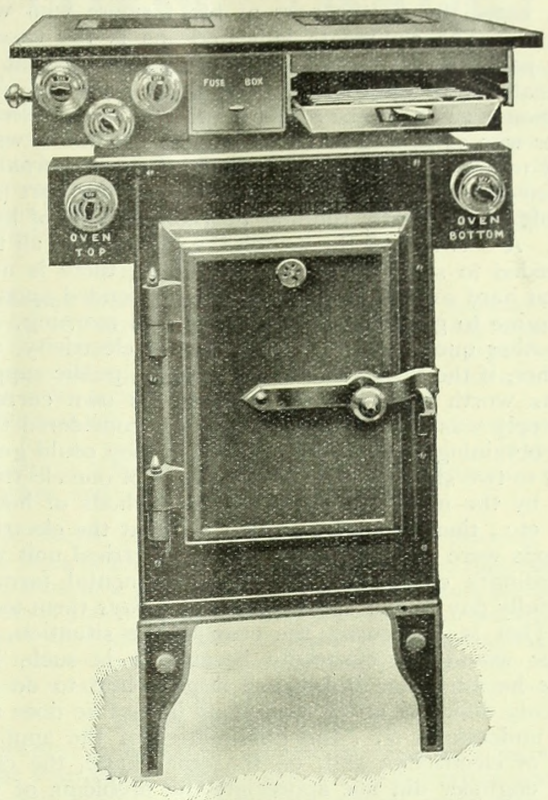


FIG. 3.

The foregoing and other cooking and water-heating appliances were shown at the Shipping Exhibition at Olympia.

OXTED ROTARIANS DISCUSS ELECTRO-FARMING.

In accord with one of the main principles of Rotary Clubs, viz.: "The quickening of individual interest in everything affecting the public welfare," the Rotary Club of Oxted and Limpsfield last week considered the applications of electricity to farming. The discussion was opened by an address from R. Borlase Matthews, M.I.E.E., who reviewed the present practical possibilities, and incidentally mentioned that whereas a year ago only about 200 British farmers were using electricity, to-day there were well over 400 farms with electric installations in this country. He referred to the rapid development that was taking place here in "making hay without sunshine," and curing corn along the lines with which he had been associated. There are now over 165 different uses of electricity on farms, hence the varied work of the farm can be materially assisted in many ways. Reference was made to the fact that on the speaker's own 600-acre farm at East Grinstead the cost of lighting the cowhouse was more than recouped by the milk that was saved from spilling. Again, by electrically restoring the longer hours of light per day to which the sub-tropical fore-

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runners of poultry were accustomed, 20 per cent. more eggs were obtained in the winter season—at the cost for electricity of the value of one egg per bird. Truly, it pays to be kind to live-stock.

This address aroused a keen and interested discussion, especially on the part of the farmers who were present. The comments indicated—as is the case in most parts of the country—that many thought that the applications of electricity were still a mystery. The question even had to be asked, as to whether an electric motor was as simple as an oil engine. It was news to many to hear that the modern squirrel cage alternating current electric motor had only one revolving part (and no rubbing contacts) running in a simple pair of bearings. A " twitch of the switch " is, of course, all that is needed to start up an electric motor, there is none of that hard coaxing which has to be expended upon an oil engine to get it to start up on a cold morning.

Another query was as to the cost of electricity, and whether, if the farmer could not obtain a public supply, it was worth his while to generate his own current. The reply was that since most farmers considered they were obtaining power very cheaply, if they could get it down to two shillings for the equivalent of one electrical unit, by the means of the ordinary methods of horse, man, etc., there was no question but that the electrical methods were cheaper, since 4d. per electrical unit was an ordinary charge for power. Continental farmers cheerfully pay higher rates—because it *pays* them to do so. That is, of course, the crux of the situation, no farmer would use electricity because it is such, but rather he must use it because it pays him to do so. The only difficulty in the way at all is that he does not fully understand . . . the possibilities of the applications of electricity; and, on the other hand, the electrical engineer did not appreciate the problems of the farmer. However, the portending signs are that both callings are beginning to get in touch with each other.

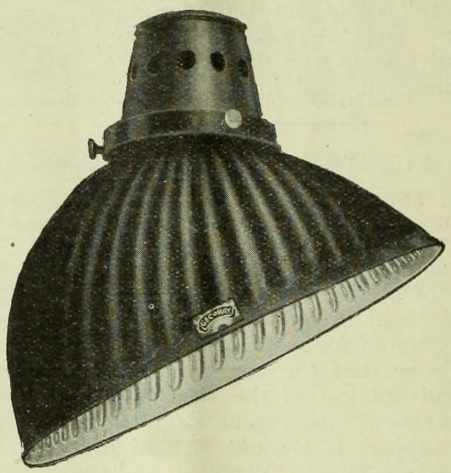
SHOP WINDOW ILLUMINATION.

No branch of illuminating engineering has made greater strides during the past few years than that of shop window illumination, both as regards the planning of the installations and the design of suitable fittings.

Modern practice is generally to install a row of lighting units on the ceiling, close to the glass, the lamps being equipped with suitable reflectors and the whole concealed by a valence or pelmet.

Of the various types of reflector produced for this purpose the most popular are the units arranged to accommodate one lamp. The " Gecoray " reflectors, recently introduced by the General Electric Co., Ltd., come under this category. The reflectors are of crystal glass with scientifically designed contours to give a correct distribution of the light, and they are fluted to aid diffusion. The reflecting surface is double-plated with pure silver, backed with a heavy deposit of pure copper electro-plated on by a process calculated to assure the permanency of the silver. The reflectors are green enamelled on the outside, and stoved at 200 deg. F. to give a permanent finish. We understand that these reflectors are guaranteed not to tarnish, check, or peel if used with the lamps specified and care be taken that the lamp does not touch the reflecting surface. Colour screens can be clipped on and held in position between two rings with restraining wires stretched across the openings of each ring.

Four standard sizes of " Gecoray " reflectors have been produced, suitable for 60 watt and 100 watt Osram gasfilled lamps and for different types of windows. Full particulars and prices are given in



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Write on one side of the paper only, and if diagrams are sent, draw them on a separate sheet of paper attached to the manuscript. Competitors may adopt a " nom de plume," but, both in the case of questions and answers, the competitor's real name and address must be sent with the manuscript as a guarantee of good faith. No correspondence will be entered into with regard to successful replies. The Editor's decision is final.

Commencing with Question No. 101, a Diploma of Merit will be awarded to the six competitors who win the first or second prize the most times during the next twelve months.

The words " Questions and Answers " or " Q " and " A " should be placed at the top left-hand corner of all letters intended for this column.

QUESTION NO. 167.

I have a large bell in my works used to signal the " commence work " and " cease work " to my employees. At present it is operated by hand. Can I electrify this so that it will work if I press a button? If so, I would appreciate the details.—" CASHIER."

QUESTION NO. 168.

I wish to convert a 220 volt D.C. motor to one of 100 volts. The machine is 4-pole, wave wound, 10 b.h.p., 750 r.p.m. Can you give me the full details to enable me to carry this conversion out?—" WINDER."

(*Replies to Questions Nos. 167 and 168 must be received not later than September 29, 1923.*)

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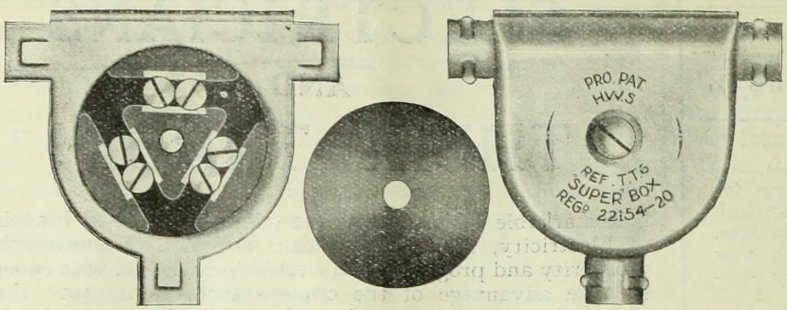
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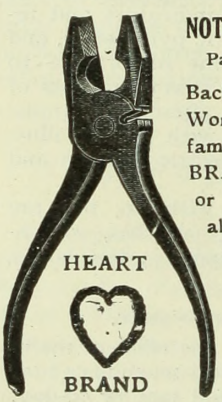
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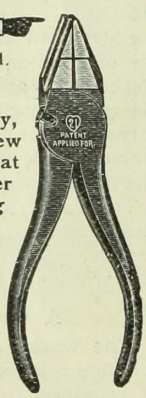


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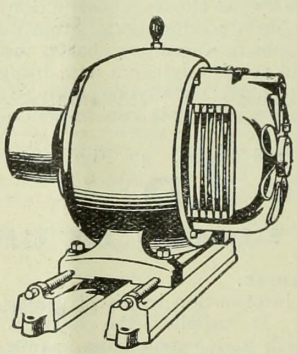
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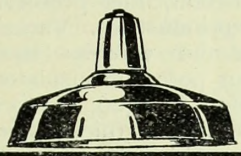
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TO OUR READERS.

ELECTRICITY is published every Friday, and, if ordered, is on sale at the principal Railway Station Bookstalls and Newsagents on that day. It has a very large sale throughout the United Kingdom, as well as in the British Colonies and Abroad.

New advertisements for the displayed columns and alterations to existing ones must reach the publishing office not later than first post Tuesday morning, in order to be in time for the issue of the following Friday. This is important. Rate quoted on application. Subscription : 13s. a year, 6s. 6d. half-year, 3s. 3d. a quarter in advance, postage prepaid in the United Kingdom and abroad.

Questions to which an answer is required must be accompanied by a 1½d. stamp for reply. When considered of sufficient interest, the answer will probably appear in the paper.

All remittances payable to the Publishers, S. RENTELL AND CO., LTD., 36-39, Maiden Lane, London W.C. 2. Telephone No. 2460 Gerrard.

Current Topics.

The British Association.

The B.A. meeting at Liverpool this year was an unqualified success, and, judging from the manner in which the city was placarded and the convenient arrangements made for quick transport of the various visiting parties to different points of interest, the organisation also left little to be desired. A feature of the meeting was a most interesting exhibition at the Central Technical Schools, where a number of most fascinating scientific novelties were on view, including the electrically operated device for enabling the blind to read by sound. The soirée, held at the University, also proved a great attraction, close on 2,000 guests taking advantage of the invitation to visit the city's leading educational establishment, and here again there were a number of very ingenious exhibits, working models and lecturettes during the three hours over which the function extended.

I had the good fortune to be present at this gathering, although business prevented me from enjoying the daily programmes and papers on topical subjects. A social gathering of this kind probably brings together in one building a greater concentration of British scientific brains than is to be found anywhere in the Empire at any other time. One recognised on all sides forms and features long familiar to the public eye through the medium of Press photography, and it would be difficult indeed to mistake such characteristic personalities as that of Sir Oliver Lodge and several other well-known celebrities in the world of science. Among the active exhibits was a small Strowger automatic telephone exchange representing the principle which is shortly to be introduced into certain of the London telephone exchanges. It was exhibited by the British pioneers of this system, Automatic Telephone Manufacturing Company, Liverpool, who were also showing a special design of Wheatstone transmitter, high speed relay and undulator for high-speed telegraph transmission. I was informed that this combination is in considerable demand for high-speed wireless telegraphy.

Another interesting demonstration of visible radio-telephony was given by Dr. E. E. Fournier d'Albe, D.Sc., with the aid of an apparatus called the "Tonoscope." It is an extremely simple device comprising a cone, the apex of which impinges on the diaphragm of a loud speaker (in this case a Claritone). Across the mouth of the cone is stretched a rubber diaphragm, supporting at its centre a globule of mercury. A beam of light from a projector is directed on to the mercury globule, and reflected thence on to a screen, where it is plainly visible to the audience. When the loud speaker diaphragm is set in motion by a note of reproduction of the human voice, the cone communicates the vibrations to the rubber diaphragm, and, in turn, to the mercury globule. As a result characteristic movements take place in the circle of projected light, and some interesting and fairly regular wave formations are apparent.

Unfortunately, the many disturbing electrical influences which abounded in the vicinity of the University on the evening of the soirée rather spoilt the effect, but Dr. d'Albe showed several slides made from photographs of more successful experiments with his "tonoscope." The same disturbing factors rather detracted from the quality of the Broadcast reception in the Arts Theatre, and it is increasingly evident that until some satisfactory form of filter is discovered for silencing extraneous noises, atmospherics, inductive disturbances, etc., demonstrations of wireless telephony under such conditions as obtain at these large public gatherings are calculated to discourage the public from participating in the new pastime.

In the field of magnetism (no pun intended), Mr. W. M. Mordey was busily engaged exhibiting to an ever-interested crowd of onlookers the weird behaviour of iron filings and other magnetic substances in the neighbourhood of alternating current poles, both single and multi-phase. Similarly, at a near-by table, Mr. F. Harrison Glew was demonstrating the capabilities of cobalt-chrom magnets in levitation, mutual repulsion, etc., experiments which are impracticable with ordinary steel magnets on account of the reversal of polarity in the strength of field necessary for flotation. Seeing that a permanent magnet was employed with only its own field to rely upon, it was somewhat weird to watch the floating bar magnet suspended in mid-air, some half-inch or more above the poles of an opposing horse-shoe.

In Plain Figures.

A letter from one of our readers, which we reprint on another page, embodies a most excellent suggestion which manufacturers of all kinds of electrical plant and machinery might well read, mark, learn and inwardly digest. He refers to the difficulty experienced by those responsible for moving such plant and machinery from time to time, in computing the approximate total weight of the dynamo, motor, machine, turbo, or other unit, and thus providing tackle of a sufficient capacity to stand the strain. It

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is a fact that makers of electric motors and other plant are not in the habit of recording the gross weight of each machine on its attached name plate, and this is an omission which could easily be rectified and would indubitably serve a useful purpose at some time or another.

It would entail very little extra trouble and expense to stamp or engrave the overall weight of the machine on a name plate which already states the voltage, power, phase, r.p.m., and other relevant data, when a glance at the accustomed spot by the erector or any other person having occasion to move the unit would at once indicate the nature of the tackle required for the purpose. Due to its varied construction and the nature of the metals employed—iron, copper, brass, etc.—it is not easy to guess correctly the total weight of any electrical machine, and although those accustomed to handling such goods daily, and in large quantities, may be close judges of what constitutes a ton of dynamo, motor, transformer or motor-generator, the man who as an erector or contractor is called upon to handle a widely varying class of goods in the course of his daily work, finds it no easy matter to assess weights. Moreover, a miscalculation may involve disaster, as in the case cited by our correspondent. Let us have the weight on the name-plate by all means; it may save broken bones or worse in the ultimate result.

All-Night Telephoning.

Our telephone service still continues to be the subject of adverse criticism from various causes, and is likely to until the work of converting all the principal exchanges to automatic operation has been actually carried out, a task which will necessarily occupy some years to come, but might have been considerably advanced by now had the authorities not dillied and dallied so long over accepting the general principle involved in the change. With the Strowger automatic telephone all causes of complaint are eliminated, including careless or dilatory operating, and the rapid switching through of night calls. The automatic exchange gives a twenty-four hour service every day throughout the year, and without necessitating any loss of sleep by late duty operators. The same all-night facility can be extended with equal facility to the telephone service in large towns and remote country villages. Strowger switches work unceasingly all the year round, and never complain of overwork or nerve strain.

ELEKTRON.

THE SHIPPING, ENGINEERING AND MACHINERY EXHIBITION AT OLYMPIA.

(*Concluded from page* 515.)

It is gratifying to be able to record that this important and instructive exhibition has proved successful. The arrangements made for the attendance of overseas buyers, and the official visits of all the recognised engineering and allied societies, provided a steady stream of purchasers and potential purchasers; at the same time there has been a pleasing absence of that type of individual whose only object seems to be to secure as much free literature as possible in the exhibition, with the object of dumping it down outside in an untidy heap. On Friday of last week over 500 members of the I.E.E. accepted the invitation of the organisers, and much appreciated the entertainment provided at the reunion.

Some exhibitors having displays of electrical interest have not been able to have their exhibits referred to in these columns on account of the limitation of our available space. To these we tender our apologies. For instance, the well-known firm of Ozonair, Ltd. (96, Victoria Street, S.W.1), made a good show of their patented systems for the electrical production of pure ozone combined with ventilation and air-heating, deodorisation, water purification, fuel preservation and air conditioning for various industries. Various accessories, including those for the wireless trade as well as H.T. and L.T. vitreous porcelain insulators were shown by Henry Joseph and Co. (96, Victoria Street, S.W.1). Alklum accumulators (nickel-steel) where shown in various patterns and sizes by Worsnop and Co., Ltd., of Carlton Lamp Works, Halifax, while various of their excellent pyrometers and resistance thermometers were among the exhibits of the Foster Instrument Co., Ltd. (Letchworth, Herts).

A more than usually interesting stand was devoted by the Rawlplug Co., Ltd. (Gloucester House, Cromwell Road, South Kensington, S.W.7), to displays and demonstrations of Rawlplugs, now so universally used for the quick, neat and secure fixing of anything into brick, tile, marble, slate, metal, etc. The new size, suitable for use with coach screws, was demonstrated. A single one of these large-sized plugs will withstand a direct stress of over three tons. Another speciality of the Rawlplug Co. is the Recess screw, which has a recess in the head so that it grips the screwdriver and enables the screw to be driven into any wood, even hard oak, without the use of a gimlet. Though not electrical, reference should also be made to the range of useful Rawlplug domestic aluminium fittings.

Several examples of their soundly constructed, small-power engines, electric lighting and pumping plants, etc., were demonstrated by Stuart, Turner, Ltd., of Henley-on-Thames, while in addition to their industrial and street lighting fittings, motors, etc., the Engineering and Lighting Equipment Co., Ltd. (Sphere Works, St. Albans), showed the "Anti-Break" device for doing away with the breakage of electric lamps due to vibration and shock. They also showed a new device for giving a uniformly graduated light distribution for industrial lighting. This has been adopted by the Admiralty for use in the dockyards. Hazeltine Neutrodyne Radio Sets, Ltd. (147, Queen Victoria Street, E.C.4), showed their wireless receiving sets, in which by the arrangement of balancing capacities to compensate for inherent self-capacity in such parts as transformers, valves, conductors, etc., a high efficiency is obtained. One result thereby obtained is a loud signal. Finally, of the many applications of electric motors to various purposes, there was on view the ingenious "Human" dough kneader and the "Victor" chopping and mincing machine, shown by Chandler, Lindsay and Co. (11-13, Upper East Smithfield, E.1). And for small-power motors, buffers, grinders, and all small-power applications where a flexible shaft is required, Walter D. Fair and Co. (43, Sackville Street, Piccadilly, W.1) can provide the equipment. With one motor and the flexible shaft for the various tools, such operations as grinding, sounding, sharpening, drilling, roughing and polishing can be carried out. The firm also supply a sewing machine motor complete with the necessary attachments.

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SIEMENS' ELECTRIC LAMPS.

NOVEL IDEAS IN EXTENSIVE ADVERTISING CAMPAIGN.

All users of electricity for lighting are being forcefully enjoined to use Siemens' lamps by means of a comprehensive advertising scheme embarked on by the manufacturers. We are able to give some particulars of this scheme, whereby the method of linking the user with the retailer can be appreciated. The campaign may be roughly described under the following heads :—

PRESS ADVERTISING.

A number of artistic yet telling advertisements will appear in the leading daily morning and evening newspapers throughout the United Kingdom. In addition, a series will be run in a large number of Trade journals, other than Electrical, appealing to large users in other trades to purchase Siemens' lamps from their dealers. Announcements will also appear extensively in the best weekly and monthly magazines, all requesting readers to go to their local dealers for their requirements in electric lamps.



FIG. 1.

POSTERS AND SHOWCARDS.

From now till well into the New Year 16 and 18 sheet posters will be exhibited throughout the country. These posters are of three designs, handsomely printed in colour. The design entitled "After Sunset" (Fig. 1) is a most arresting picture, and should be seen by some hundreds of thousands throughout the country. It will also appear in all the trains on the following Tube railways : Bakerloo, G.N.P. and Brompton, District, Central London, Hampstead, City and South London.

Double-crown posters with the attention compelling showcard design, "The Midnight Sun," will appear on the platform approaches of all stations from Hammersmith to Finsbury Park and from Liverpool Street to Marble Arch.

The "Midnight Sun" showcard, printed in ten colours, eyeletted and strung for hanging for display in shop windows, etc., will be sent to resellers on request. Further, supplies of the "Satisfied Consumer" showcard are available.



FIG. 2.

SIGNS

Three colour enamelled signs in two sizes, 12 inch by 4 inch, and 27 inch by 9½ inch also form part of the scheme. These signs are suitable for fixing in interior or exterior positions, and a considerable number have already been erected. A limited supply is still available.

There are also available electric window signs (see Figs. 2 and 3) in two designs :—(*a*) "Fountain," and (*b*) "After Sunset." They consist of a triangular



FIG. 3.

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metal container, with slots for a lampholder and a wire attachment, over which a cylinder revolves behind the scene. The heat of the lamp keeps the cylinder revolving. The "Fountain" signs show a bright café and garden, with fountain playing, the effect produced being that of running water, and is indeed novel. The "After Sunset" sign shows the world in bright colours, with a very fine cloud effect. A changing lighting effect is obtained with a special revolving cylinder. Single lights are illuminated one at a time through small holes from the bottom of the globe to the top; all remain alight for a few seconds, and then are all extinguished at once. The pictures and cylinders for these signs are interchangeable. There are a number of these signs which may be obtained on loan, and early application is desirable in view of the heavy demand for them.



FIG. 4.

WINDOW DISPLAYS.

In addition to the foregoing there are larger window displays :—

(1) A road scene with illuminated buildings, motor car and sea view in the distance (shown illuminated in Fig. 4), and

(2) An interior casement window scene looking out to sea (shown illuminated in Fig. 5).



FIG. 5.

These displays are ready assembled, and only require opening out and the struts fixed. Both are most interesting, and possess pleasing and engaging features, especially when lighted up after dusk. These are to be loaned out to the Trade, and can be booked in advance.

NOVELTY CARDS FOR CIRCULARISING.

There are two of these, one is a folded cut-out with an "After Sunset" picture on the cover. On opening the card the sun disappears and an electric lamp comes into place beneath a shade. The other is a plain post-card, on the address side of which is a seal with printed instructions, which read :—

"Open seal, moisten blotting paper and rub therewith interior surface of card."

This operation instantly produces a good fixed photograph of the "Midnight Sun" showcard.

These are being mailed to thousands of consumers throughout the U.K., and recipients are requested to go to their local dealers for their supplies of Siemens' Lamps.

PRICE LISTS.

The requirements of the Trade for Lamp Price-lists are well met with a Vacuum and Gasfilled Lamp Leaflet No. 86, and an Automobile and Battery Lamp Leaflet No. 87. Both of these have a very pleasing and appropriate cover design, on which is provided a space for overprinting the dealer's name and address. Some thousands have already been overprinted, and supplies to resellers who have not yet received them will be sent on application to Siemens and English Electric Lamp Co., Ltd. (38-9, Upper Thames Street, E.C.4).

Correspondence.

IN PLAIN FIGURES.

To the Editor of ELECTRICITY.

SIR,—I should like to suggest, through your paper, an item which I consider would be very valuable if adopted.

That is, if on specification plates of generators, motors, transformers, and other such heavy and costly machinery, the weight or approximate weight were quoted.

I have recently been engaged on reconstruction work, and had several fairly large motors and transformers to handle in places where overhead cranes are out of the question, and much time and labour has been spent in getting heavy tackle to make sure of not having a mishap.

I know of a case where a 200 h.p. motor was wrecked, owing to chain blocks breaking, which was due to under-estimating the weight to be lifted.—I am, Yours faithfully, D. A. EVANS.

7, Mill Street, Blaina, Mon.,
September 17.

New Address.—Electrical Utilities, Ltd., state that their new factory is now completed, and their address from 20th inst. is Tudor Works, Park Royal, London, N.W.10. New telephone: Willesden 3180. New telegraphic address: "Utilelec, Harles, London."

Removal.—The British Thomson-Houston Co., Ltd., beg to inform their customers in the North of England that on and after September 24, the address of their Leeds office will be 19A, Wellington St., instead of Standard Bdgs., City Square, as heretofore. This move has been necessitated by the rapidly increasing business of the office. The showrooms and stores at the new address will be far more commodious than those at Standard Bdgs., and it will be possible to carry large stocks, not only of Mazda lamps, but of all kinds of electric light fittings, accessories, Radiola wireless sets, etc., etc. The telephone number of the new address is No. 28011, and the telegraphic address, "Asteroidal, Leeds," as before.——On and after the 18th inst., the address of the Inst. of Cost and Works Accountants is 6, Duke Street, St. James's, London, S.W.1. Telephone number, Regent 5407.

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Reviews of Books, &c.

[Books noticed in this column will be sent from ELECTRICITY *Office to any part of the world, for the published price, plus five per cent. for postage (minimum 2d.), and orders will be appreciated.]*

AUTOMATIC TELEPHONE SYSTEMS. Vol. II. By W. Aitken, M.I.E.E. (Ernest Benn, Ltd. 35s. net.)—This second volume on the fascinating subject of Automatic Telephony follows the same general arrangement as Volume I. in regard to the uniform arrangement and numbering of circuits—termed bus-routing from its similarity to the method of indicating the various London 'bus routes. The author has also found it necessary, due to the rapid development of the art in the interval between the publication of the two volumes, to augment his descriptions, and a further volume will be necessary to deal with the additional matter arising from this development. As in Vol. I. the principle is followed of a sub-division into sections, each dealing with a specific subject; there are 67 of these sections in the present volume, six of them constituting a supplement to Vol. I. Commencing with extension and party line working, descriptions are given of small automatic telephone installations either subsidiary to a public system, e.g., community or village exchanges, or private and self-contained inter-departmental systems for works, offices, etc. With the exception of the supplement to Vol. I., the detailed description of these smaller systems together with the manifold arrangements for inter-switching and control from the main exchanges with which they connect, special services, etc., the major portion of the book is devoted to this subject, thus leaving the all-important matter dealing with large metropolitan networks such as are at present in rapid development, for treatment in the promised third volume. In the supplement, special interest attaches to the clear detailed description and illustrations of the new standard Post Office Dial which is claimed to overcome some alleged minor defects in previous models and is universally applicable to the various systems in use by the department. Summarising, the present volume, like its predecessor, is essentially a compendium of existing information on the art of automatic telephony, and in no sense a text-book. The author does not attempt to draw distinctions between the various competing systems, or to criticise the designs and circuits of newcomers to the field of development in the light of what has been achieved by the original Strowger pioneers. The application of automatic switching to telephony is so complex a subject that only prolonged experience and intensive application both in the research, manufacturing, and operating fields can ensure ultimate success, and most of the later systems have a long row to hoe before they can hope to establish themselves on the firm basis represented by the quarter of a century or more experience in automatic telephony already enjoyed by the sponsors of the original Strowger system. The diagrams are exceptionally clear and reflect great credit on the draughtsman, although in some instances they might with advantage have been somewhat simplified without detracting from their immediate utility. A book such as the present one is a necessarily expensive production, which probably accounts for its high published price, a figure which unfortunately places it beyond the reach of the average student, to whom, however, it can be most cordially recommended as a highly instructive work which should improve his grasp of present-day telephone engineering.

TABLES AND MEMORANDA FOR PLUMBERS, BUILDERS, SANITARY AND ELECTRICAL ENGINEERS, ETC. By J. W. Clarke and E. C. Roche. 330 pp., illustrated. (Batsford, 3s. 6d. net.)—This handy little volume, which slips easily in the waistcoat pocket, contains a wealth of useful practical data on a great variety of subjects. It is now in its sixth edition and contains a new and enlarged series of electrical tables and memoranda which appear to us to be thoroughly sound, although they are, of course, neither so numerous nor so comprehensive as in a purely electrical pocket book. We feel, however, that this book will be particularly useful to a number of wiremen and other electrical workers because of the information which it gives on plumbing, building and sanitary matters. Though "every man to his trade" is an excellent maxim, it is often necessary for the practical man to go somewhat outside his own field, and it is precisely in such emergencies that it is useful to have a volume of this kind ready to hand. The pocket book has evidently been compiled most carefully and strictly from the practical point of view, and we have every confidence in recommending it to those of our readers who require a small work of reference covering the diverse subjects indicated by the title.

GENERATION OF ELECTRICITY IN GREAT BRITAIN; FUEL CONSUMPTION, ETC., RETURNS FOR YEAR ENDING MARCH 31ST, 1923. 11 pp. (H.M. Stationery Office. 1s. 6d. net.)—This publication contains the analysis and summaries of the four-weekly returns rendered to the Electricity Commissioners in respect of the year ending March 31st last. The Commissioners are to be complimented upon the promptitude with which these valuable statistics have been made available to the industry, and also upon certain material improvements which have been effected in the tables themselves. For example, the names of the leading stations are now given, and the basis of comparison between stations has been modified so that stations are only compared with those operating under similar conditions. A matter of satisfaction is the statement that whereas the total output showed an increase of 17.5 per cent., the total consumption of fuel increased by only 3 per cent.

SMALL ELECTRIC LIGHTING SETS. By C. F. Caunter. Cl. 8vo, 264 pp., 70 illus. (Munro, Glasgow. 3s. 6d net).—This book is certain of a hearty welcome from quite a large number of interested readers. It deals very clearly with the practical erection and running of small engine-driven plants of the type which has had such a ready sale during the past few years, and the demand for which is likely to increase still more in the near future. The second chapter, which describes the actual utility of the petrol electric set, is very instructive and should go a long way towards convincing likely purchasers of the work which can be carried out by the plant and the efficiency it can be made to represent. Other chapters deal with the internal combustion engine, ignition, carburation, lubrication, etc., while the sections on the dynamo, batteries, switchboard and erection are also very clear and explanatory. The book can be cordially recommended.

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ELECTRIC LAMP DEVELOPMENTS.

(Concluded from page 500.)

The energy radiation in the visible range must be corrected by these percentages in order to obtain the curve showing that part of the radiation which is effective on the eye. This reduces the effective radiation in the visible range to, perhaps, one-third, and the visible efficiency (Table I.) is the ratio of the energy experienced as light to the total energy radiated. This ratio reaches a maximum of 14.5 per cent. at a temperature of about 6,500 deg. C. absolute, and corresponds to 90.3 lumens per watt. At higher temperatures the visual efficiency decreases because the maximum radiation occurs at shorter wave-lengths than those to which the eye is sensitive. If we had a source which radiated only in the visible range, and in such manner as to produce white light, an output of 248 lumens per watt would be obtained at 4,250 deg. C. absolute. If the entire radiation were at the wave-length (556 $\mu\mu$), to which the eye is most sensitive, the output would be about 620—680 lumens per watt, but such a coloured light would not be acceptable for general lighting. Assuming that, for general purposes, we must have white light, the highest attainable efficiency from an incandescent source is about 248 lumens per watt. This is far higher than the 40—55 lumens per watt obtainable from the flame arc and quartz-mercury lamp respectively, which are the most efficient sources yet known; neither of these lamps, moreover, gives white light. Again, though some substances give selective radiation to quite a marked degree, there is no hope of obtaining an incandescent body which radiates only in the visible range. We are thus reduced to a probable limit of 90 lumens per watt (14½ per cent. visual efficiency), and even this would demand a temperature of 6,500 deg. C. absolute, at which the intrinsic brilliance would be as great as that of the sun (Table I.). The avoidance of glare would then be a problem indeed, and a great part of the efficiency of the source itself would have to be sacrificed by the use of diffusing globes or shades. The Moore lamp alone (with the exception of the neon night-light) has an intrinsic brilliance which the eye can regard without discomfort, and, as stated in Table I., the visual efficiency of this lamp is considerably lower than that of the tungsten lamps.

The Trend of Progress.—The visual efficiency of the firefly is well over 90 per cent., and if only we could imitate the light of this insect on a commercial scale we should have a near enough approach to a lamp of ideal efficiency. Recent advances indicate that a solution to the problem will be found in our increasing knowledge of atomic structure. By electrical means it may be possible to bring about such movements of electrons as will generate light. If free electrons can be obtained by a sufficiently small expenditure of energy we have, in this direction, the promise of obtaining a high percentage (if not complete) radiation in the visible range and thus the possibility of realising 100 lumens per watt, or even higher efficiencies.

For the present, however, the more important problem, so far as the ordinary consumer is concerned, is to apply to best advantage the lamps already available. The methods of doing this are well understood by illuminating engineers, but the services which the latter can render are too often overlooked by those who use lamps.

Various Items.

Personal.—Mr. A. Hugh Seabrook, M.I.Mech.E., M.Inst.E.E., consulting engineer, states that his private address from this week is: Wyllyotts Manor, Potter's Bar, Middlesex. Telephone: Potter's Bar 100.

The I.E.E.—The opening meeting of the session will take place on Thursday, October 18, when Dr. Alexander Russell, M.A., D.Sc., will deliver his inaugural address as president. The premiums awarded for last session's papers will be presented on this occasion.

Export Trade.—Reports of the Economic and Industrial Conditions in Esthonia and in Canada have been issued by the Department of Overseas Trade, and may be obtained from H.M. Stationery Office or from ELECTRICITY Office, prices 1s. 2d. and 2s. 8d., post free, respectively. They contain information which will be of direct interest to all who wish to improve their export trade in these countries.

Marketing Inventions.—The successful marketing of novel devices demands legal knowledge and financial ability, besides the protection of Letters Patent, if these can be obtained. Some firms specialise in this kind of work, one being King's Patent Agency, Ltd., Wardrobe Chambers, 146A, Queen Victoria St., E.C.4. In addition, the firm is prepared to give inventors initial advice free of charge, any inquiries, of course, being treated in strict confidence.

The Electrical Trades Benevolent Inst.—The Annual Festival of this Institution will be held on Wednesday, November 14, 1923. Sir Phillip Nash, K.C.M.G., C.B., has very kindly agreed to be the President of the Festival this year, and it is to be hoped that he will receive the strong support of the members of the electrical industry, both by their contributions to the funds of the Institution as well as by their presence at the dinner. This will take place at the Trocadero Restaurant on the above-mentioned date.

Australia.—According to the foreign trade report for the year ending June 30, 1923, Australia imported electric cable and covered wires to the value of £1,205,706 during the twelve months 1922-23, as compared with £888,184 in the twelve months 1921-22. Also they imported electrical machinery and appliances value £3,380,424 for the former period, as compared with £3,098,925. This shows a satisfactory increase of trade in both cases, although the actual countries of origin are not stated Let us hope that the bulk of them came from Great Britain.

Plant Wanted.—The New Zealand Public Works Department invite tenders for portable testing instruments for Mangahao Electric Power Plant.——The Municipal Council of Sydney invite tenders for high-tension feeder and pilot cables.——The Horowhenua (N.Z.) E.P. Board invite tenders for the supply of lightning arresters, switches, etc.——The P.W. Dept. at Wellington, N.Z., wants two recording instrument panels.——The Municipal Council of Johannesburg invite tenders for joint box compound, cut-outs and insulating tape. Copies of the various specifications and general conditions of tender can be inspected by British firms at the D.O.T. (Room 52), 35, Old Queen Street, London, S.W.1.

Meetings.—The first monthly meeting of the new session of the Birmingham and District Electric Club will be held to-night, Friday, September 28, at the Grand Hotel, at 7 o'clock, when there will be a lecture by Major A. M. Taylor, M.I.E.E., of the B'ham E.S. Dept., on "Underground Cables for High-Tension Supply."——The Annual Ladies' Night of the club will be held on Friday, October 5, and the programme will be similar to that of last year, viz., a whist drive and dance. Tickets, 6s. each single, including refreshments, from F. S. Ette, 14, Harbury Road, Cannon Hill, Birmingham.——The first of the Autumn Session meetings of the Diesel Engine Users' Assoc. this year will be held on Friday, October 5, at the I.E.E. Non-members interested in the work of the Association and desirous of attending the meeting can make application for tickets of admission to Mr. Percy Still, the Hon. Sec. of the Association, at 19, Cadogan Gardens, London, S.W.3.

A very useful illustrated price list of all those items comprised in the term "electrical supplies" has been issued by **Donovan and Co.** (47, Cornwall Street, Birmingham).

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A POPULAR SCIENTIFIC WEEKLY JOURNAL
ELECTRICITY
A PRACTICAL TRADE JOURNAL

OCTOBER 5, 1923.

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THE MANUFACTURE OF STEAM.*

By W. E. Highfield, M.I.E.E.

We had the pleasure of attending a meeting of the National Association of Supervising Electricians at the St. Bride's Institute, Ludgate Circus, London, on September 11. The occasion was the presidential address of Mr. W. E. Highfield, M.I.E.E. We publish the address exactly as it was read, not only because we feel sure that it will be appreciated by the whole of our readers, but we are of opinion that no good purpose will be served if we merely publish abstracts from it.

The chair was occupied by the chairman, Mr. F. T. Alldread, who, after the reading of the paper, with Mr. Parsons and Mr. C. Sylvester, A.M.I.E.E., A.M.I.Mech.E., took part in the discussion. Mr. Sylvester, while agreeing with Mr. Highfield that cheap steam was essential if the cost of units were to be decreased, pointed out that cheaper units would mean a greater use of electricity. This, in turn, would mean the building of more turbines and generators, switchgear, etc., thus benefiting the electrical industry as a whole.

It is my privilege to-night to address an audience of essentially practical men, all of whom are directly or indirectly concerned in the cheapness with which electricity can be generated. I have therefore chosen a subject for discussion upon which, as I shall presently show, the economical generation of electricity depends to a degree which is hardly realised, and I intend to deal with it in an essentially practical manner. I have purposely worded the title as the "manufacture" of steam because the word implies something that is commercial, and it indicates as no other word does the main point that I wish to impress upon you to-night. During the last few years a good deal of attention has been given to boiler-house problems, with the result that the central station engineer has been almost overwhelmed with exhortations and advice from men who, though frequently not engineers at all, feel themselves competent to instruct him in his business. Instruments and apparatus of every kind, guaranteed almost to compel efficiency by the mere fact of their presence, are offered to him, and, if some of his advisers had their way, the generation of power, which is, after all, the main object of his plant, would almost be lost sight of in comparison with the analyses and tests which he is urged to carry out. Efficiency, however, is not to be obtained by decorating the boiler-room with expensive instruments. It calls for a thorough realisation of the simple fundamentals upon which good plant management is based, and in so far as these essential matters are attended to, so will economy in generation be the result.

To endeavour to deal with power-station management generally would lead me into a field far wider than I could traverse in a single evening. I shall, therefore, confine myself almost exclusively to questions relating to the boiler-house, touching only upon others aspects of power-station work when necessary to the presentation of my principal subject. It is, moreover, in the boiler-house almost entirely that good or bad station management produces the most tremendous effects. The efficiency of the electrical apparatus in a power station is conditioned by its design. A modern electric generator at full load will produce electric energy to the equivalent of about 96 per cent. of the mechanical energy with which it is driven, however well or badly it is operated. If it is treated badly it will break down all the sooner, but so long as it runs its efficiency will always be substantially the same. The steam turbine which drives it is not quite so independent of the operator, but provided the proper vacuum is maintained and the machine is kept in good mechanical condition, the efficiency with which the heat of the steam is turned into mechanical work will hardly vary. It is clear, therefore, that the engine-room of a power station offers little scope for increase in efficiency due to the efforts of the operator, and if he keeps the plant in good order, gives unremitting attention to his vacuum, and never runs two units when one would safely carry the load, he can reasonably count upon satisfactory results.

The efficiency of an engine-room, therefore, as measured by the quantity of steam used per kilowatt-hour turned out, is a matter which is very largely outside the control of the operating engineer. The makers of the machinery have set a figure once for all, and this is bound to be obtained unless something is obviously wrong, always assuming that the plant is operated with ordinary intelligence. The engineer-in-charge may be handicapped by uneconomical steam-driven auxiliaries or by other features of the lay-out, but so long as he pays attention to the points I have mentioned he can hardly fail to get the best results of which the plant is capable.

With regard to the boiler-house, the management of which is the subject of my address to you to-night, matters are entirely different. The results obtained from a boiler plant are almost entirely dependent upon the manner in which it is operated and maintained. Boiler design has now settled down along fairly definite lines, and there is probably very little indeed to choose between modern power-plant boilers on the score of efficiency. Any reputable maker would undoubtedly guarantee to supply a boiler which, with super-heater and economiser, would transmit 80 per cent. of the heat of the fuel to the steam produced. The competition

* Presidential address before the N.A.S.E., September, 1923.

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between different makers rests, therefore, rather on questions of cost, ease of cleaning, accessibility for inspection and similar points.

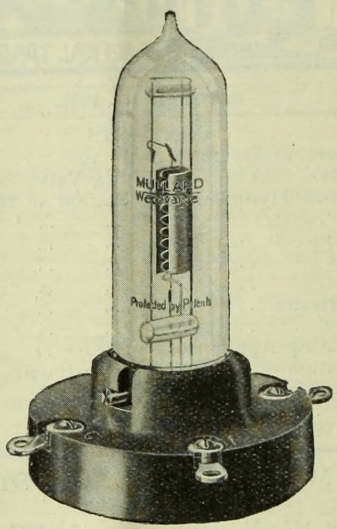
Efficient boiler-house management consists in realising in practice that a boiler-house is a steam factory, and neither a place for burning coal, as some people seem to think, nor a kind of chemical and physical laboratory, as others would have it. It is a commercial factory for making steam by the use of coal, and the aim of the manager must ever be to produce his steam with the least possible cost in fuel. He must, of course, also take care that his labour and maintenance costs are not unnecessarily high; but the coal bill is the great thing to watch, as you will admit when I remind you that in an ordinary power station it is not unusual for the cost of coal per unit of electricity generated to exceed the whole of the other costs added together, including the capital charges. The predominating part played by coal consumption in affecting costs is hardly ever realised even by those most directly concerned. If an engineer could save 50 per cent. of the cost of his lubricating oil he would think he had made an important economy, but if he reduced his coal consumption by only five per cent., which could be done easily, by comparison he would be making a far greater reduction in operating costs.

From these remarks you will realise that it is absolutely essential to efficient operation that the manager of the "steam factory" should know exactly how much coal he uses and how much steam he makes with it. Coal should be weighed coming in, as a check against the invoice weights, so that no more is paid for than is actually received. This is, of course, only in accordance with the custom of checking the raw material delivered to any factory, and has little bearing upon the efficiency with which the coal is used. To know this, it is not sufficient to know how much coal has been burnt during a month. It is essential to know how much has been burnt on every shift, and how much water has been evaporated by its use. Only by having the figures at the end of the shift can the manager know how the plant is being operated in sufficient time to rectify any source of inefficiency the moment it occurs, whether due to some fault of the plant or to the failure of the human element.

(To be continued.)

THE "WECOVALVE."—A NEW RECEIVING VALVE FOR WIRELESS.

On the 1st inst. a wireless receiving valve of miniature dimensions, for operation from a single dry cell, was put on the market. It is known as the "Wecovalve," and is shown in the accompanying illustration full size as made by the Mullard Radio Valve Co., Ltd. (45, Nightingale Lane, Balham, S.W.12). By its use the necessity for accumulators is done away with, and, owing to its robust construction, the risk of mechanical breakage is reduced to a minimum. Further, a life of more than twice that of any other bright or dull burning valve is claimed. Owing to "Wecovalves" having a very low self-capacity, due to the absence of long leads and pins, they are particularly suitable for the reception of broadcasting and other short wavelengths. In addition to the socket illustrated, the Mullard Co. supply a four-pin adaptor, so that the new valves can be used in place of existing valves. When in operation the filament should glow a dull red and take 0.25 amp., the voltage being 0.8 to



Mullard "Wecovalve" and Socket (full size).

1.1. The detector anode voltage is 17 to 22, and the amplifier anode voltage 22 to 45. For use with these valves, the Mullard radio "A" dry cell has been developed.

THE LINTON LOCK HYDRO-ELECTRIC STATION OF THE CITY OF YORK.

(*Concluded from page* 508.)

The speed of the sets is controlled by two automatic oil-pressure governors. By a very simple arrangement the servo-motor of the main set can control the gate apparatus of the two large turbines, or if one of them is not running its gate apparatus can be disconnected from the servo-motor; under the last-named conditions the horizontal shaft of the idle turbine is disconnected from the generator, and the set runs with one turbine only in exactly the same way as the small set does. Oil-pressure governors have been adopted as being much more sensitive and more reliable than any others, their power transmitting agent being at the same time their lubricating agent. Moreover, with oil-pressure governors, energy can be easily stored.

To read the oil pressure, gauges are fitted on each governor, and for indicating the speed, each set has a tachometer. As regards the fall, both head and tail races are connected to a water level recorder which traces on a daily chart the head under which the turbines are working.

The question of the choice of generators, whether D.C. or A.C., was given careful consideration. With D.C. generators the turbines could have been designed to run with varying speed, thus working with the same efficiency under varying heads, but such an arrangement is complicated and, moreover, it was found that the transformation of D.C. into A.C., as required by the transmission line, would have necessitated an expensive motor-generator set. A.C. generators were therefore adopted, and are of the three-phase, 50-cycle type working at a terminal pressure of 6,600/7,500 volts.

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The large alternator has been designed for 675 kva. (540 kw. at 0.8 power factor), and runs at 300 r.p.m. The small one runs at 375 r.p.m. and is designed for 262.5 kva. (210 kw. at 0.8 power factor). Both generators can withstand the runaway speed of the turbines, which is about 1.9 times their normal speed.

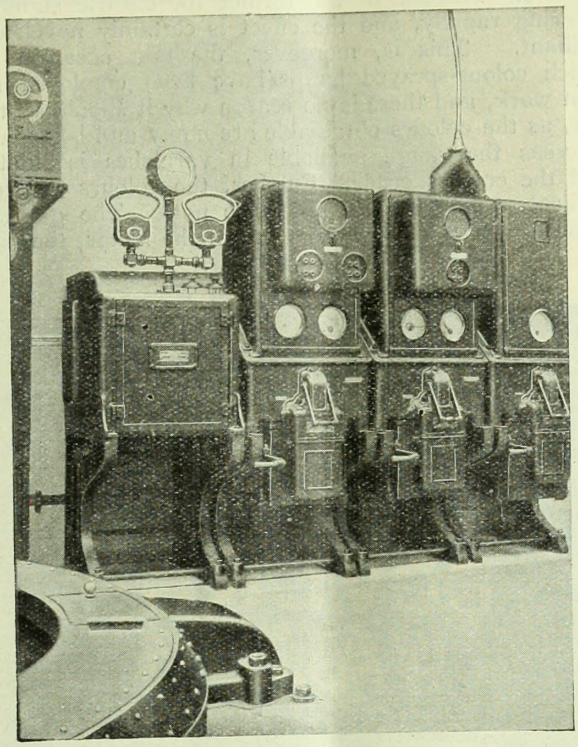


Fig. 2.—The Main Switchboard.

The full load efficiency of the generators is about 94 per cent.; taking 80 per cent. as the average efficiency of the turbines and allowing 2 per cent. losses in the bevel gears, the overall efficiency of the power station is, therefore, about 74 per cent.

The switchboard for controlling the two generators and one feeder is of the English Electric Company's standard SXC cast-iron draw-out pillar type, and is illustrated in Fig. 2. This class of board is particularly suitable for a station of the kind in question, as it combines a high degree of safety with extreme compactness. Each pillar consists of two main portions, a stationary portion with supports and the sliding carriage carrying the oil switch, trip coils, instruments, etc. Isolating devices are arranged so that by withdrawing the sliding carriage the oil switch and other apparatus is entirely isolated from all live parts and can be inspected without danger of accidental contact.

The oil switches are of the hand-operated free handle type with the "English Electric" patented spring tank attachment, in which the tanks are attached to the top by means of a spring suspension device. The usual air cushion above the oil level, a fruitful source of explosion in many switches, is entirely omitted, and care is taken to eliminate all air pockets from this space; thus the gases caused by the arc when breaking current cannot mix with air and form an explosive mixture inside the switch. The level of the oil extends upwards into a narrow space enclosed by the rim of the oil vessel and the joint is made sufficiently tight to prevent oil splashing over accidentally, but is not intended to be gastight. Any momentary pressure, therefore, caused by breaking a heavy overload current is thus relieved through the medium of the spring suspension device, and at the same time any small amounts of gas are able to pass upwards and escape under the flange of the cover.

All live parts are completely enclosed and the pillars are fully interlocked in order to render them fool-proof. It is not possible to withdraw the carriage unless the switch is in the "off" position, and the carriage cannot be pushed into contact with the live conductors except with the switch tripped and the oil tank and top cover in position. The oil tank and cover can only be removed when the carriage is withdrawn and is consequently dead, thus affording complete protection from accidental contact with live conductors. Protection is afforded to the generators by three overload coils and a reverse power relay for each machine, operating through

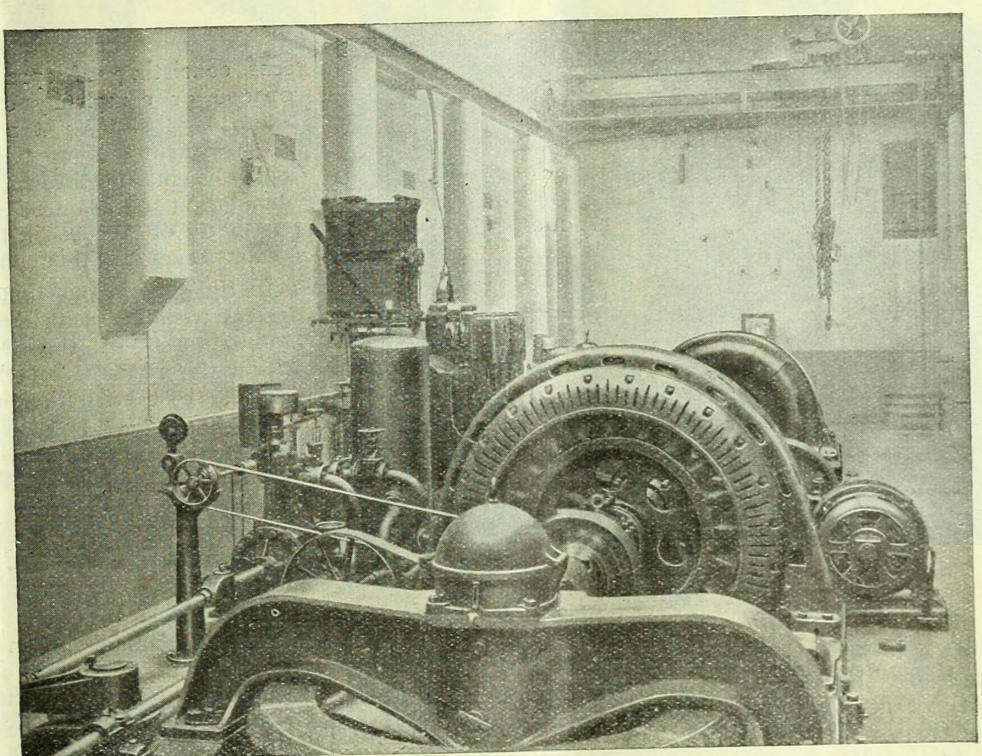


Fig. 3.—Interior of Power House.

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an auxiliary relay on a low voltage trip coil energised by the individual exciter of the machine. Protection of the feeders is by simple overload coils. The feeder oil switches are fitted with buffer resistances and charging contacts, and a special earthing switch is provided for earthing the cables.

A similar non-draw-out pillar matching up with the remainder of the board carries the synchronising gear and potential transformers.

Owing to restriction of space the exciter gear is accommodated on a separate flat-back panel mounted on the wall adjacent to the switchboard, as seen in the illustration.

GOOD FOR OSRAM

—At Any Rate.

No, we have in Piccadilly Circus the largest electric sign ever built and erected in England, and from the point of view of candle-power the largest in the world. Does this herald a race between the U.K. and the U.S.A. for supremacy in this field? We hope not. Further international complications are not wanted. If you are in doubt about this, see daily morning and evening papers.

The use of electric signs ought to be encouraged more than it is throughout the country as a whole, as these signs have a decided advertising value, and if conceived on dignified lines, with some kind of artistic relationship to their surroundings, can actually add to the amenities of a district. Moreover, their use is obviously of benefit to both the electricity supply and manufacturing industries.

Sign advertising at Piccadilly Circus is, however,



Fig. 1.

just a little bit overdone (some find the effect rather dazzling), although it can be claimed that the signs do not at present hide any features of architectural merit.

Meanwhile, our business is to keep our readers informed of technical developments, so please refer to the illustrations (Figs. 1 and 2) which are reproduced from night photographs and explain the sign to some extent. There are 5,000 Osram lamps used to illuminate it—60-watt Daylight Gasfilled lamps for the channel letters, and colour sprayed Osrams for the borders. The use of the former for electric signs is growing rapidly, and the effect is certainly novel and brilliant. This is, moreover, the first occasion on which colour-sprayed lamps have been employed for sign work, and there is no reason why it should be the last, as the colours obtainable are many and beautiful; whereas the range available in varnishes is limited and the colours crude. Further, the colours are permanent, which varnish tints are not. The glass is coloured during the manufacture of the lamps, the pro-



Fig. 2.

cess consisting of spraying the bulb with a semi-opaque or completely opaque enamel of appropriate colour, and stoving it on at high temperature. In addition to modifying the colour of the resultant light a highly efficient diffusion is obtained, resulting in the elimination of filament glare and opening up the possibility of the use of high illuminating and striking colour schemes without the risk of garishness.

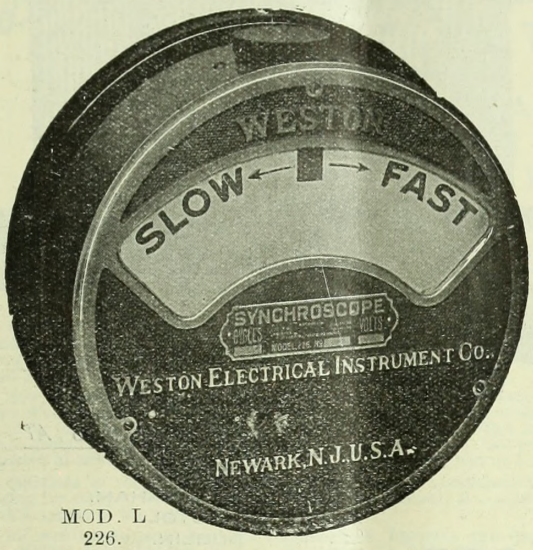
In the sign in question the border lamps are tinted apricot to fall in with the colour scheme. They were manufactured at the Osram-G.E.C. Lamp Works within the 14 days between the placing of the order and the first exhibition of the film.

The total load is some 200 kw., necessitating the provision of a special service main. The sign was built by the Boro' Billposting Co., Ltd., and the Strand Electric and Engineering Co., Ltd., to the instruction of Mr. Mortimer Norden (president and general manager of the Northern Sign Co., who, we are informed, are the largest manufacturers of electric signs in the U.S.A.).

This gentleman, in an interview, is said to have declared that, with this new sign in load, Piccadilly Circus has a far more effective display of signs than Broadway, New York City, and that it would not have been possible to have produced so large a sign in America in the short time available (14 days). What a pity!

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WESTON ELECTRICAL MEASURING INSTRUMENTS



MOD. L
226.

The WESTON Synchroscope

The indications of this Synchroscope are infallible.

A glance at it shows immediately to what degree the incoming machine is fast or slow.

The movement of the pointer is smooth and certain, and inspires confidence.

The superior designs and construction of the instrument ensure a very long life and permanent accuracy throughout its life.

It indicates exact synchronism within one degree of true phases coincidence throughout a wide range of frequency and voltage.

It is impossible to make an error in synchronising with it.

We invite the most minute and critical examination of the instrument, both electrically and mechanically, in comparison with any other synchroscope at present manufactured, and we are confident that a comparative test of the instrument will easily demonstrate the superiority of the Weston Synchroscope.

Write for full particulars.

WESTON ELECTRICAL INSTRUMENT CO., Ltd

Telephone: Holborn 2029. **Audrey House, Ely Place, Holborn, E.C.1.** *Telegrams:* "Pivoted, Smith, London."

EDISWAN ACCUMULATORS

for EVERY PURPOSE

The uses to which Accumulators can now be put are numerous, but no matter for what purpose a battery is required—whether for a hand-lamp or for house lighting—there is an Ediswan Accumulator made to meet the need. A full range of Accumulators is contained in the new Ediswan Catalogue No. A.A. 253.

ASK FOR A COPY.

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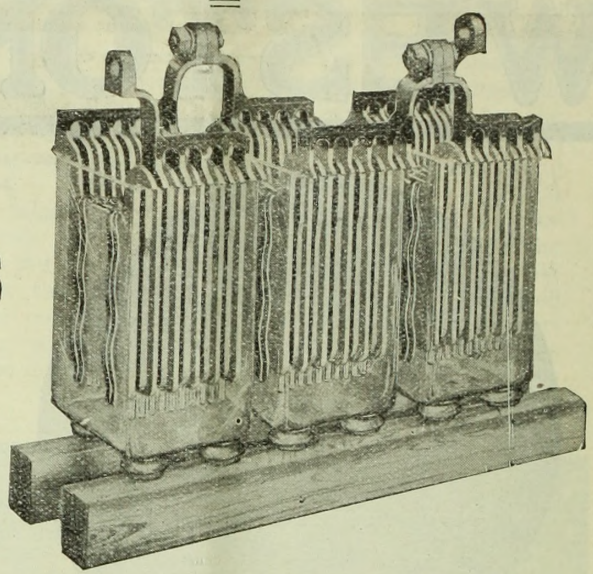
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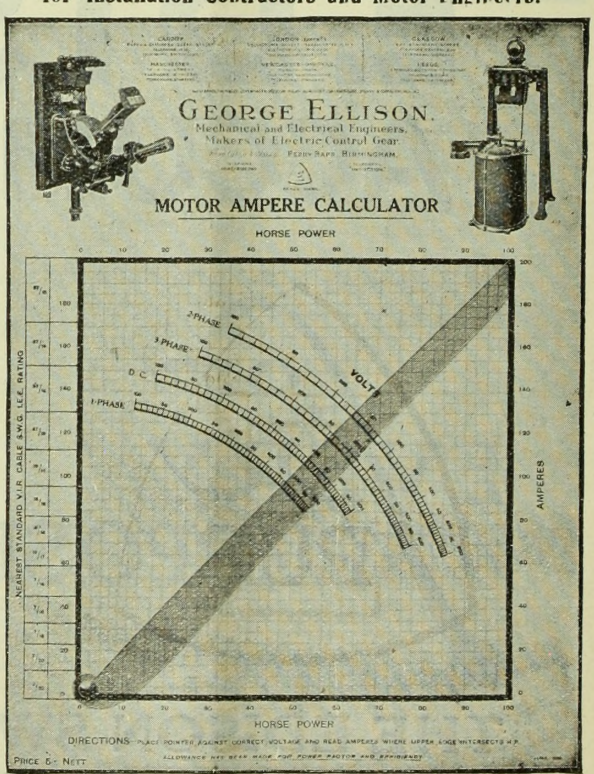
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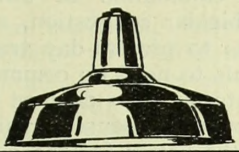
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TO OUR READERS.

ELECTRICITY is published every Friday, and, if ordered, is on sale at the principal Railway Station Bookstalls and Newsagents on that day. It has a very large sale throughout the United Kingdom, as well as in the British Colonies and Abroad.

New advertisements for the displayed columns and alterations to existing ones must reach the publishing office not later than first post Tuesday morning, in order to be in time for the issue of the following Friday. This is important. Rate quoted on application. Subscription : 13s. a year, 6s. 6d. half-year, 3s. 3d. a quarter in advance, postage prepaid in the United Kingdom and abroad.

Questions to which an answer is required must be accompanied by a 1½d. stamp for reply. When considered of sufficient interest, the answer will probably appear in the paper.

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Current Topics.

The —— Limit.

A warning to prospective consumers has been issued by the Electricity Supply Department of the Labour Borough of Stepney, couched in the following terms :—"Intending consumers, before placing orders for the wiring of premises, should take steps to see that the contractor employs only Trade Union labour. Instructions have been issued by the Union concerned to all its members employed in this undertaking not to connect any installation carried out by non-Union Labour.

"The Electricity Supply Committee express no opinion on the matter, but they think it important that prospective consumers should be made aware of the facts."

And so do I. A Bolshevik pronouncement such as this should be broadcast far and wide, together with the identity of the source whence it springs. If I had the misfortune to reside in the area served by this communistic undertaking that would settle the question for me right away, I would either eschew electrical service altogether, or put in my own private plant, and take particular care to select non-union labour to fix it.

When a Labour minority sets out to dictate not only to members of its own branch of industry, but also to the general body of the public whom it ostensibly serves, what they shall and shall not do in the matter of spending their own money, it is time to kick, and kick hard. Trades unionism is not so popular to-day among the masses of workers that it can afford to arrogate to itself the autocratic powers of Lenin and Trotsky. In any event, the majority of decent thinking working men are too sensible to permit themselves to be controlled by fanatical minorities. The affair has its humorous side, inasmuch as this decree means cutting off the trade union nose to spite the face of the same body. Obviously all ratepayers with any self-respect would not knuckle under to such arrogant terms, and the net result will be to discourage the growth of the local undertaking, with a consequent considerable loss of employment not only among wiremen, but also those employed in the manufacture of lamps, fittings, and other current consuming devices. My strong advice to intending consumers in Stepney is to "wait and see."

The Breakdown Season.

What will soon become to be known as the Electricity Supply Breakdown season has commenced, and during the past week there have been serious failures in lighting and supply at the Post Office, King Edward Street, and at Fulham, respectively. At the time of writing no official explanations as to the causes are available; but I mention these two preliminary instances as a warning to supply station engineers and mains superintendents to subject their respective systems to a rigid survey for incipient weaknesses, in view of the increased winter loads, thus aiming at prevention or anticipation of possible annoying breakdowns at a later date. We are very jealous of the reputation of electrical service for reliability, and it is up to the supply undertakings to maintain that reputation.

The November Elections.

Coming events cast their shadows before, and the imminence of the municipal elections in November is foreshadowed by certain announcements of immediate reductions in municipal tramway fares, electricity supply tariffs, and other insidious concessions to the man in the street whom the average councillor, seeking re-election, regards as a colossal M—U—G, and not without reason. It is really amusing to hear the comments of the innocents on the wonderful success of the local electricity and tramway undertakings at this time of the year. How well they must be managed, and how considerate the Committees are in cutting off that extra penny, and letting us have our current cheaper. The future alderman's pound of flesh is invariably overlooked, and "Vote for Bloggs —He made tram-fares cheaper" receives a rousing welcome at the November polls. When will it dawn on the intelligent electors that municipal wanglers always keep these little concessions up their sleeves, although they might well give the public the benefit months in advance?

The Mersey Tunnel.

Like the Channel Tunnel, the perennial project of a tunnel under the bed of the River Mersey to link up Liverpool with the Cheshire side of the river has again been revived for the umpteenth time. In view of the growth of local trade, traffic, and population, the scheme is about twenty years' overdue, for there is hopeless congestion in the cross-river traffic, and has been since the early days of the war. I have myself waited in a queue of vehicles for three-quarters of an hour in the vain hope of crossing by ferry, as far back as 1915, and then gave up in disgust and travelled via Runcorn Transporter Bridge. Whether the present scheme matures or no is a moot question having regard to the general tendency to talk a lot and accomplish nothing, which has been the fate of most

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previous revivals of this time-worn project; but, at all events, the present scheme appears to be strongly supported, and is based on the recommendations of eminent engineers.

There are no insuperable difficulties, and, as a war measure, the necessary tunnel could have been driven and open to traffic in far less than the two years now specified. There appear to be two controversial points associated with the proposal, one of which concerns finance, the estimated cost of the tunnel being six millions, whilst the other has to do with the effete suggestion to carry tramways through the tunnel. Curiously enough Liverpool authorities can only think in terms of their semi-derelict tramway service, which was one of the earliest in the provinces, and bears daily evidence of its age. The tramway system, the tramways load on the power station, the tramway personnel, the enormous number of passengers carried annually, the tramway receipts and tramway expenditure, overshadow everything else handled by the local Electricity Committee, and it is this tramway megalomania which probably accounts for the backwardness of Liverpool in domestic electric supply.

Now there is likely to be a modern and commodious tunnel under the Mersey, the City Fathers again drag in their pet tramways, and stipulate that these obsolescent vehicles shall be accommodated with full running powers and facilities to the total exclusion of pedestrian traffic. There is probably method in their madness, inasmuch as the imposition of tramway fares upon all who essay to cross the river by this means affords a convenient method of taking toll for the privilege. On the other hand, why burden a traffic tunnel with the incubus of a passenger transport system, which may be as obsolete as the proverbial Dodo in another ten or fifteen years? The city tram service is even now a cause of considerable congestion in the busier streets of Liverpool, and by the time the tunnel is completed the problem is likely to have become much worse. Already tramways are barred from central London, and in all probability it will be necessary to similarly restrict their movements in Liverpool as well as other large provincial cities. For congested thoroughfares they are already obsolete.

As regards finance, there should be no difficulty in raising the necessary capital to construct the tunnel and its approaches. As a national asset the State should, and probably will, contribute upwards of fifty per cent. of the outlay. Once the scheme is in being, and the tunnel completed, however, it should not be a perpetual charge upon the community. After all, six millions are not hard to come by, spread over a term of years; I see it reported that the total number of passengers carried across the Mersey during 1921 by the existing Mersey Railway and the Ferry Steamers respectively was no less than 62,900,000, so that if every one of these passengers paid some two shillings a head per trip, the capital cost of the tunnel would be wiped out in twelve months, and that, surely, would be preferable to a prolonged era of vexatious tolls, with their attendant cost of collection.

Reverting to tramways, my own impression is that the next quarter of a century will see city passenger transport problems solved on the distributed load principle by means of moving side walks, escalators, and perhaps light railways on the "never-stop" principle recently demonstrated at Southend. The advantages in the matter of load distribution, the avoidance of congestion, the elimination of strap-hanging, fighting for seats, vehicular congestion, and all the other obvious drawbacks to present-day tramway traffic are sufficiently obvious to need no comment on my part. In any event, the tramway is doomed for central city service, and the sooner its sponsors realise this fact, and act accordingly, the better for the community at large.

The Never-stop Railway.

Elektron.

B. E. X.

A recent visit revealed that very considerable visual progress has been made during the last few weeks in the construction of the several handsome buildings which will house the varied exhibits at the British Empire Exhibition (Wembley) next year. The largest and most important buildings, such as the Palace of Engineering and the Palace of Industry, are "permanent" edifices of steel, brick and concrete. India is a "semi-permanent" structure, of steel, wood and plaster, and will be a very attractive building. Of the remaining erections most are "temporary", i.e., the framework is of wood. We understand that flood lighting will be largely used and that most of the general lighting will be of the concealed type. The lake bids fair to be a truly ornamental piece of water spanned by several artistic bridges, and will be lighted at night on novel lines—the lamps being in shallow draught anchored boats with glass bottoms, through which the light will pass to mirrors on the bed of the lake, whence it will be reflected upwards so that the whole surface of the water will be illuminated. A feature of the lighting will be colour effects.

Internal transport (for those who do not wish to walk from one building to another) will be by a fleet of battery-driven vehicles of various kinds. The railway facilities would seem to be ample, the stations being large and conveniently arranged, while direct sidings are run into the grounds for delivery of goods *in situ*, e.g., the Palace of Engineering has seven bays, down the centre of each below floor level runs a railway track. Thus exhibits can be lifted by the overhead travelling cranes and deposited in the exact position required. When the last is in place the tracks will be covered by movable flooring.

We noted also the very large motor parks for the accommodation of road vehicles, and the thorough precautions being taken against the possibility of damage to the exhibition by fire. Even in inclement weather the major part of the exhibition can be seen without the visitor exposing himself to the elements.

It is interesting to note that over ten million pounds is being spent in preparation for this, the largest exhibition ever held, and that between April and October a minimum attendance of 20 million people is expected. The price for admission has been fixed at 1s. 6d.

The latest information to reach us is that the Society of Motor Manufacturers and Traders, Ltd., who are

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contributing £10,000 towards their exhibit, which will occupy 50,000 sq. ft. and will embrace every kind of motor vehicle, are arranging for the actual practical demonstration of agricultural motors and power farming implements close to the exhibition.

SECONDARY BATTERIES.

A Reliability Test.

An interesting letter, indicating the long life and reliability of chloride accumulators for country house lighting, was received recently by the Chloride Electrical Storage Co., Ltd., from a user (who describes himself as an amateur) in South Wales. The letter reads:

"My storage battery of 15 cells, Ref. No. A.3275—7 plates, S type, put in in April, 1909, has given me the greatest satisfaction and no trouble, but unfortunately about 18 months ago I found it impossible to run the plant, and the cells were left standing. I have commenced to run it again, and really so far the cells seem wonderful. Now would you advise me to put a little acid in? They have had nothing but distilled water all these years. If they need acid will you kindly forward me a carboy of 1215. . . ."

Correspondence.

ELECTRICITY AND THE PRESERVATION OF FOOD.

To the Editor of Electricity.

Sir,—Public interest has been aroused by articles in the Press on the use of food preservatives.

A recent writer pointed out that much of the food preservation work carried out now with chemicals could perhaps be effected with "cold"—he suggests that "cold" might be laid on like water, gas and electricity.

It would be a convenience to lay on "cold" and "vacuum" as we do electricity and water; the time for it perhaps is not yet, but there is a problem for the inventor which has never been solved, even if it is capable of solution—that is, the easy abstraction of heat from bodies but little hotter than the surrounding air.

It is so simple with the electricity to deliver heat or raise the temperature of a body, and so much more complicated to deliver "cold" or extract heat from a body.

There are refrigerating appliances, but they mostly contain reciprocating machinery, and the smallest are apt to represent considerable expenditure.

The inventor who can give us the inverse of the electric fire and for a few pounds provide a cupboard or receptacle in which a body can be chilled or kept cold by a small expenditure of electrical energy should secure a big reward.—Yours faithfully,

J. W. Beauchamp,
Director and Secretary, E.D.A.

September 28th, 1923.

Meetings.—There will be a meeting of the Societe des Ingenieurs Civils de France (British Section) in the lecture theatre of the I.E.E., Savoy Place, Victoria Embankment, W.C.2, on Wednesday, October 10, 1923, at 6 p.m., when Mr. Roger T. Smith, B.Sc., will deliver his presidential address for the session 1923-24.

NEW XCEL HEATING APPLIANCES.

Two new Xcel devices have just been put on the market by the manufacturers, Automatic Telephone Manufacturing Co., Ltd. (Milton Road, Edge Lane, Liverpool). They are a new design of Xcel domestic iron and the Xcel-Fulray fire. The former is loaded to 400 watts and can be obtained of 5 lb. or 6 lb. weight. The price is remarkably low for a thoroughly well-designed and finished article. The original Xcel irons, of which over 100,000 are in use, have been improved recently in some particulars. A label guaranteeing the element "for all time," subject to certain reasonable conditions, is sent out with each iron.

The Fulray fire has an element designed to prevent sagging of the wire, and the whole element glows a cheerful red. It is easily removable from the back. The copper reflector bowl is of deep parabolic contour and has a strong hinged flat-wire guard. A special feature is the large diameter base, which makes it difficult for the fire to be overturned. Even should this happen the heat rays are thrown upwards, away from the floor. A novel arrangement is also provided for adjustment of the angle at which the heat rays are directed. In this case also the list price is low.

A NEW PUBLICATION ON FEED-WATER TREATMENT.

The electrical power-station engineer will be interested to learn that a new publication has just appeared, giving, in simple and concise fashion, the whole of the chemical principles involved in the treatment of boiler feedwater for the prevention of scale and corrosion, particularly from the point of view of proper operation of softening plant.

This book, *Water Treatment*, has been issued by Messrs. Brunner Mond and Co., Ltd., the well-known chemical manufacturers of Northwich, Cheshire, and may be obtained free of charge on application to the above address by anyone interested. The treatment of feed-water, as far as the electrical engineer is concerned, is rather unusual, as it may be said to consist essentially of two sets of problems, first, the softening of the ordinary hard make-up water, and secondly, the treatment of the mixture of the latter with the condensed water as actually going into the boilers.

The efficient working of the softening plant undoubtedly in many power stations does not receive the best attention, partly because it is a chemical problem, and also because the make-up is regarded as rather a subsidiary matter. This latter is, of course, an erroneous opinion, and the former difficulty, a very real one in many cases, can be largely remedied by a study of this book, which is divided into 14 sections. Special attention is given to the more difficult aspects of the matter, such as the removal of oil and greases and acids of various descriptions, both mineral and organic, together also with free CO_2.

One frequent defect in softening plant is that the settling capacity is too small, whilst a common trouble is the removal of the last traces of magnesium, and the methods of avoiding this and other difficulties are clearly explained. Certainly every effort should be made to see that the make-up water is reduced to at least 5 grains of hardness all the year round, and preferably 3-4 grains; and the great advantage of the

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lime and soda ash treatment is that the water is delivered not only softened, but containing no soluble saline salts, so that the tendency to priming, a serious matter, of course, in water-tube boilers, is reduced to a minimum.

Questions and Answers by Practical Men.

RULES.

QUESTIONS : *We invite our readers to send us questions, preferably on technical problems that have arisen in actual practice. Questions which we consider of sufficient interest to our readers will either be replied to under "Answers to Correspondents" or replies will be invited from our readers. One shilling will be paid for the question which we select for competitive replies in this column.*

ANSWERS : *A fee of 10s. will be paid for the answer which we consider shows the greatest merit, and 5s. for the one we select as second best. In judging the replies, importance will be attached to clearness and conciseness, as well as accuracy. The Editor reserves the right to make no award, or to accept only one reply, if, in his opinion, the answers received do not possess sufficient merit. Competitors desiring the return of their manuscripts, if unaccepted, should enclose stamped addressed envelope.*

Write on one side of the paper only, and if diagrams are sent, draw them on a separate sheet of paper attached to the manuscript. Competitors may adopt a "nom de plume," but, both in the case of questions and answers, the competitor's real name and address must be sent with the manuscript as a guarantee of good faith. No correspondence will be entered into with regard to successful replies. The Editor's decision is final.

Commencing with Question No. 101, a Diploma of Merit will be awarded to the six competitors who win the first or second prize the most times during the next twelve months.

The words "Questions and Answers" or "Q" and "A" should be placed at the top left-hand corner of all letters intended for this column.

QUESTION NO. 169.

I wish to make a resistance to reduce a pressure of 200 volts to 25 volts. I would appreciate details of size of wire, method of mounting coils, etc. The maximum current I wish to take from it is 15 amperes.—J. R. WOODHATCH.

QUESTION NO. 170.

I desire to make a testing board suitable for testing motors, elements, etc. The supply is 200 volts. Can any reader tell me what instruments and apparatus I shall require, and method of mounting?—J. R. WOODHATCH.

(*Replies to Questions Nos. 169 and 170 must be received not later than October 27, 1923.*)

Answers to Questions.

QUESTION NO. 163.

I have a room 32 ft. long and 18 ft. wide. I wish to light it with electric light. I wish to produce about 6-foot candles intensity at the working plane, about 4 ft. from the ground. I would appreciate details of how many points to fit and the candle-power of the lamps.—"CUTTER."

REPLIES TO QUESTION NO. 163.

The first prize (10s.) has been awarded to "M. M." for the following reply :—

The accompanying sketch, Fig. 1, illustrates a suggested scheme of lighting.

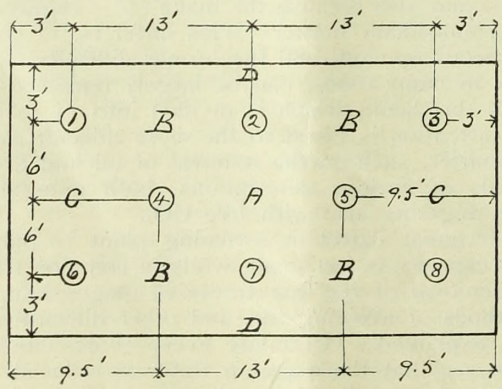


FIG. 1.

1-8 are 100 c.p. incandescent lamps. *A*, *B*, *C* and *D* are points on a horizontal plane four feet above the ground. The lamps are supposed to be six feet above this plane.

Consider the illumination at point *A*, this will be the middle point on the plane.

Calculate from the formula :—

$$\text{Illumination } (I) = \frac{\text{power of source (c.p.)}}{(\text{distance})^2\ (d^2)} \times \alpha$$

where α = incident angle of light.

The whole of the eight lamps illuminate the point *A*. Take first the two lamps, 2 and 7, these lamps are at an equal distance from *A*, and therefore give an equal illuminating effect.

$$I = \frac{\text{c.p.}}{d^2} \times \cos \alpha$$

$$= \left(\frac{100}{72} \times \frac{6}{8.4}\right) 2 = 1.98 \text{ foot candles.}$$

Fig. 2 will make this clear. Similarly we find lamps 4 and 5 give 1.72 foot candles. Nos. 1, 3, 6 and 8

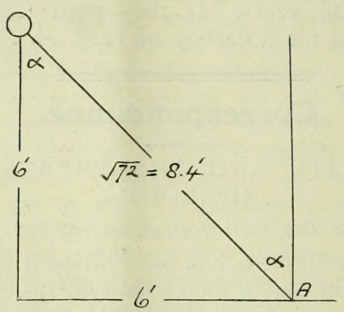


FIG. 2.

each give an equal effect. To calculate this we must find distance on the working plane between *A* and the vertical point below one of these four lamps. This is

$$= \sqrt{6^2 + 13} = \sqrt{205} = 14.3 \text{ feet.}$$

Proceeding as before, we find that the effect due to lamps 1, 3, 6 and 8 at point *A* is = .64 foot candle.

Therefore at *A* the total illumination is = 1.98 + 1.72 + .64 = 4.34 foot candles.

Similarly : illumination at *B* = 3.4 f.c. ; at *C* = 3.28 f.c. ; and at *D* = 3.38 f.c.

Ordinary enamelled conical iron shades will be found quite satisfactory ; more elaborate shades must have suitably fitted lamps in order to show any great advantage.

By employing 200 c.p. lamps, with frosted bulbs, a pleasantly diffused illumination of approximately six-foot candles will be obtained.

This arrangement will be simple to wire, and with three switches will give facility for regulation.

If thought necessary, a larger number of lamps, say, 14 of 60 c.p., could be arranged to give a more equable illumination. "M. M."

The second prize (5s.) has been awarded to "F. P. S." for the following reply :—

This problem can be attacked in several ways from both the scientific and practical aspect. The former is naturally more exact and necessary in special cases,

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but the latter is generally of sufficient accuracy. The data given in this problem is so broad that any attempt to deal with it on such a method as the "polar curve" would at once involve useless assumptions. It is therefore best to treat the problem by the total flux method.

We have here a room of 32 ft. × 18 ft., thus having an area of 576 sq. ft. on which the required illumination is 6 c.p. ft. This would correspond to a total flux of 576 × 6, that is 3,456 lumens

Now the number of points for illumination is best fixed by the dimensions of the room, as the room must be divided into a number of parts approximately square, unless very special reflectors are to be employed. In this case the room can be conveniently divided into two parts 18 × 16 ft. (Case A), or into eight parts 9 × 8 ft. (Case B), with a lamp in the centre of each part or section.

Now if we assume that all the luminous flux is given to the working plane in Case A, we shall require lamps of 3,456/2, or 1,728 lumens, and in Case B lamps of 3,456/8 or 432 lumens.

It is now necessary to consider the height of the room, the nature of the decorations of both ceiling and walls, and the kind of reflector used.

If the reflector is of the prismatic glass variety an allowance of from 5 per cent. to 30 per cent. must be made for absorption in the reflector, a quantity that naturally may be increased to 10 per cent. or 60 per cent. if the reflectors are dirty.

Even then a certain amount of light must directly reach the walls and ceilings, so that another allowance has to be made. Very good estimates can be made if the nature of the ceiling and walls are known, but here no data is available, so we will assume that the walls and ceiling are mediumly dark, and allow an extra 50 per cent. for this loss, in addition to the 10 per cent. assumed lost in the glass of the reflector.

We will now deal with the two cases in parallel columns:—

	Case A.	Case B.
Estimated lumens per unit ...	1,728	432
Add 10 per cent. for absorption...	173	43
Total	1,901	475
Add 50 per cent. allowance due to absorption at ceilings and walls	950	238
Total lumens required per unit	2,851	713

The lamps available according to the figures of the lamp-makers are:—

Case A:—

240 volts 200 watts giving 2,500 lumens (gasfilled).
,, ,, 300 ,, ,, 4,200 ,, ,, ,,

Case B:—

240 volts 60 watts giving 550 lumens (gasfilled).
,, ,, 100 ,, ,, 1,200 ,, ,, ,,

It will be noticed that the illumination is much more efficient in Case A, which is due to the higher efficiency of the high wattage lamps. The voltage of the lamps has been assumed to be 240, as this is now the most common voltage, and the lumens per watt are somewhat dependent on the voltage. Lamps of a lower voltage would give a larger illumination or more lumens for the same consumption of current.

In Case A it is quite probable that the smaller lamp would give the required illumination; but in Case B we should have to use the larger lamp, unless we used a 240 volt 100 c.p. vacuum lamp. Needless to say this would not add to the efficiency, as the current consumption would be greater than with the 100 watt lamp mentioned before.

The method adopted in Case B, with the eight points, would be better as regards the uniformity of illumination, as in Case A approximately uniform illumination could only be obtained with very expensive reflectors. This would be largely balanced by the saving in the cost of installation of the two points only, in place of the eight required in Case B.

The height of the reflectors depends on the particular make selected, and can at once be seen by the information given by the makers. It should be noted that in Case A it would be important to obtain the exactly correct height for uniform illumination, but in Case B this is not so essential. "F. P. S."

BROADCASTING.

The Licence Question Now Settled.

The long-awaited decision of the P.M.G. with regard to the issue of licences, provision and control of Broadcasting, etc., were published on Monday night, together with the report of the Committee appointed to investigate the muddle which had ensued "largely owing to the unforeseen facility, cheapness and popularity of the construction of home-made sets," and to formulate suggestions to get the industry again in a healthy state.

The P.M.G. has adopted the Committee's proposals to a very considerable extent, but not entirely, *e.g.*, the Committee recommends the issue of a single licence for 10s. (of which 7s. 6d. would go to the B.B.C.), but in view of the existing agreements the P.M.G. has introduced a temporary licensing scheme, to run until the end of 1924, as follows:—(1) 10s. licences in respect of receiving sets marked "B.B.C." are continued. (2) "Constructor's" licences at an annual fee of 15s. are available on application to a Post Office (as and from yesterday) for listeners-in who make their own sets. Only a simple form has to be filled up, the most important part of it being a declaration that the applicant will not knowingly use parts of other than British manufacture. To those who already possess unlicensed manufactured or home-made sets (without limitation as to the country of origin of the constituent parts), a special interim licence will be issued at a fee of 15s., provided they make application before the 15th of this month. Under these conditions no charge will be made and no proceedings taken in respect of past user. (It is estimated that at least 200,000 persons come under this category.) (3) The issue of "experimenter's" licences, at an annual fee of 10s., will be continued from the G.P.O. to bona-fide experimenters, who undertake not to use the broadcast programmes except for experimental purposes. The above system of licensing will be continued till December 31, 1924, after which it will be possible for the single form of Broadcast Reception licence, recommended by the Committee, to be intro-

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duced "without any condition as to the marking or origin of the licensed apparatus if it should then be thought desirable."

Parliament will be asked to approve the payment to the B.B.C. of 12s. 6d. and 7s. 6d. from the 15s. "Constructor's" and 10s. "B.B.C." licences respectively. An advisory board to assist the P.M.G. is to be appointed.

Royalties on approved apparatus to the B.B.C. are to be cut down, so that a reduction in prices should be possible. Provided that the B.B.C. supply a satisfactory service and erect additional stations where the P.M.G. may consider them necessary, he will not license any other broadcasting service before December 31, 1924. After that date the policy will depend entirely on the initiative shown by the company in giving listeners-in the varied and efficient service to which they are entitled.

The Committee's Report is full of suggestions which cannot be dealt with here in this issue. The great point is that every user must now pay his quota towards the cost of the services rendered him, and the P.O. is armed with authority to proceed against unlicensed users of receiving sets.

DISEASES MET WITH IN STORAGE BATTERIES.

Storage batteries possess several advantages in a power and lighting installation, and among these may be mentioned :—

(*a*) the low resistance of the cells (of the order 1-1,000 ohm), the high e.m.f. (about 2.4 volts), and therefore the furnishing of heavy currents.

(*b*) the ease with which they may be re-charged.

(*c*) their use as an auxiliary in taking the "peak" load in a generating station, the generators charging-up the cells during the low output period of the day.

Despite these assets, there is much to be said on the "debit" side, and this is especially so in considering the diseases to which they are subject. These are :—

(1) *Sulphating.*—Unless proper care and maintenance are taken, this soon sets up and gives rise to deterioration. It is now recognised that it is due to the formation of an insoluble sulphate—a molecular compound of the normal sulphate ($PbSO_4$) and the oxide (PbO), thus having the composition (Pb_2SO_5). It forms during discharge and is found in white patches on the plates, and, as it will not easily re-dissolve, the capacity of a cell is thereby reduced.

The contributing causes are over-discharging, under-charging, using acid of the wrong specific gravity, and allowing a cell to be out of commission for a long period. There is no "royal" remedy for restoring such a cell to its normal voltage, and the best advice is to follow rigidly the instructions laid down by the makers, more especially stopping the discharge when the voltage falls to 1.8 Experience shows that a good course to follow is to give a long-continued charge below the normal until the plates have assumed a reddish-brown colour for the positive, and a grey colour for the negative.

(2) *Buckling.*—This is the distortion of the positive plate, and is consequent on sulphating, and, in its turn, may set up short-circuiting. It is allowed to be due to the change in density—there is an increase in volume, as the sulphate has a higher specific gravity than the peroxide, PbO_2. This brings about unequal expansions when the cell is in operation, the grid being thereby distorted. By not discharging too rapidly or too far would ensure that the latter would expand uniformly and buckling avoided.

(3) *Sediment in Cells.*—Material which may fall from the plates, especially the middle ones, will accumulate at the bottom and ultimately short-circuit the cell. The acid should be siphoned off and the sediment washed out.

"In and Out" of Commission.—If a long period is to elapse—say, several months—before using a cell, charge up to 2.4 volts and discharge slowly until the voltmeter reads 1.8 volts. Siphon off the dilute acid, fill with water and discharge until the voltage is nil. Now connect the terminals for twenty-four hours and draw off the water. When putting in commission again, add the electrolyte—sulphuric acid diluted with four parts of distilled water—so that the specific gravity is 1.25. The acid should be free from iron, arsenic, nitric or hydrochloric acids, so that the commercial acid should not be used, but chemically pure oil of vitriol.

Indications of a fully-charged Battery.—There are three tests which, taken together, form a guide as to a battery which has a complete charge, viz. :—

(*a*) *"Boiling" or Gassing.*—This would denote that the charging current is being uselessly employed in electrolysing the water of the dilute acid, without a corresponding production of the active material on the positive plate.

(*b*) The test with the hydrometer—there will be a rise in density, owing to the sulphate being turned out of the paste into the acid.

(*c*) The voltmeter reading across the terminals.

Low Voltage Cells.—Sometimes several cells in a battery will not charge up to the voltage indicated by the others, and several methods may be used to restore them. One of the best is to give such cells an individual charge by a small generator called a "milking booster," without disconnecting them from the battery when the latter is discharging. Another way is to over-charge the whole battery until the low cells rise to the rated value, or, lastly, cut them out of circuit during several discharges and in again during charge.

THE ARMATURE WINDER'S FRIEND.

Winder : "Hand me the 'armature winder's friend,' Joe."

Joe : "What do you mean?"

Winder : "The black anti."

Joe : "That's not the armature winder's friend. The only friend we have is 'Armature Winding,' by Sylvester. It's 8s. post free from ELECTRICITY office."

East Anglia.—A London financial group has obtained control of East Anglian Electricity, Ltd., with a view to developing it on much larger lines. Mr. A. Hugh Seabrook, M.I.Mech.E., M.I.E.E., of Sir Charles Bright and Partners, Ltd., consulting engineers to the company, has prepared an extensive scheme for the electrical development of rural East Anglia, and the services of Mr. B. G. Drummond, M.I.E.E., have been secured as general manager of the company, whose headquarters in the meantime will be at Felixstowe. Mr. Drummond has been manager and resident engineer to the Hendon E.S. Co., Ltd., one of the most successful undertakings in the country since its inception sixteen years ago.

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Reviews of Books, &c.

[*Books noticed in this column will be sent from* Electricity *Office to any part of the world, for the published price, plus five per cent. for postage (minimum 2d.), and orders will be appreciated.*]

Technical College, Bradford: Prospectus 1923-24.—We have pleasure in bringing to the notice of our readers the new prospectus of diploma and special day courses in the Bradford Technical College. The courses of study include civil, mechanical, and electrical engineering; also textiles, chemistry, dyeing, biology, mathematics and physics. There is a most liberal list of college awards and scholarships, and the social side is well catered for, and from a perusal of the prospectus we are most favourably impressed by the admirable equipment of every department. There is evidently every facility for the acquisition of that technical training which is so essential to our industrial future.

Engineers' Pocket Technical Dictionary, French-English. By M. Lvoff. Pp. 150. (Spon, 3s. 6d. net.)—This useful little book contains a large number of engineering and technical words which, it is claimed, are not to be found in other dictionaries even of much larger size. It is particularly concerned with mechanical and electrical engineering, the iron and steel industry, aeronautics, the motor car and cycle industry, and legal and commercial words used in contracts and specifications. The author's long experience in the professional translation of technical literature affords him excellent opportunity of choosing the subject matter for a work of this kind. We have already learnt much from it, and propose to keep it on our desk ready for immediate use. The price, it will be noted, is extremely reasonable, and we have no hesitation in recommending this dictionary to our readers.

Electricity Supply in the London and Home Counties District, 1920-21-22. Pp. 59. (King, 5s.)—These returns relate to electricity supply in the London district, and show the various authorities with the authorised areas of supply, together with an analysis of the accounts of each undertaking for the year ending March 31, 1921 (or December 31, 1921), and also miscellaneous statistics for the same period, relating to capacity, output, charges, assessments, etc. This information is, of course, of the utmost value to anyone concerned with electricity supply in the Metropolitan district, and the publication, which includes two excellent coloured maps, is recommended to our readers as a most useful work of reference.

The British Acetylene and Welding Handbook. Prepared by a committee of the British Acetylene and Welding Association. 384 pp. (illustrated). 7s. 6d. net., 8s. post free.—This authoritative book of reference relating to the acetylene and oxy-acetylene welding industries is literally indispensable to everyone engaged in the carbide, acetylene, oxygen and welding industries, and it is equally useful to traders and buyers. It provides in compact and convenient form all the statutory and official orders, regulations, transport conditions, etc., relating to acetylene and calcium carbide; and in addition there is a great deal of technical information relating to the properties and use of acety-

For Electrical Engineers & Electricians

Just Out.—NEW EDITION OF W. P. MAYCOCK'S POPULAR HANDBOOK—

ELECTRIC WIRING TABLES

Fourth Edition, thoroughly revised by F. Charles Raphael, M.I.E.E., so as to bring it into line with the recent changes in the I.E.E. Wiring Rules and in the Standard Table of Copper Conductors which has been adopted by the Cable Makers' Assn. Handy in size (it is printed on very thin paper, and fits into the vest pocket), it is a book which every electrical engineer and practical wireman should carry. Price 3/6 net.

ELECTRIC WIRING, FITTINGS, SWITCHES AND LAMPS

By W. Perren Maycock, M.I.E.E. A thoroughly practical book for engineers, wiremen and students. Fifth Edition, with 620 illustrations, 628 pp. 10/6 net.

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PRACTICAL ELECTRIC LIGHT FITTING

By F. C. Allsopp. New (Ninth) Edition just out. Thoroughly revised and largely re-written, this edition deals with the newest types of lamps and fittings, heating and cooking appliances, the new systems of house wiring, testing, meters, and private house installations. With 269 illustrations. 7/6 net.

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"We tried it with several pet questions and it answered them all in record time."—*The Electrical Times.*

"The work as a whole can be confidently recommended as a valuable addition to the library of the electrical engineer."—*The Electrical Review.*

Full particulars and Complete List will be sent post free on request

PITMAN'S PARKER STREET, KINGSWAY, W.C.2

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lene, and all the equipment and accessories for acetylene welding, cutting and lighting. Illustrated descriptions of all the leading types of acetylene generators form one of the many useful sections of the book, and other useful features are the lists of patents, books and periodicals. This volume will undoubtedly be widely welcomed as *the* handbook on acetylene.

Various Items.

Tenders Accepted.—The tender of Siemens and English Electric Lamp Co., Ltd., has been accepted by the G.P.O. for Siemens vacuum and gasfilled type lamps in quantities as may be demanded from time to time during the twelve months ending August 31, 1924.

Hospitality.—A public luncheon in honour of the Dominion Prime Ministers and other delegates to the Imperial Conference is being given by the British Empire Producers' Organisation at the Fishmongers' Hall, London Bridge, on Friday, the 19th inst. The chairman of the organisation, Mr. Ben H. Morgan, will take the chair.

F.T.C. Old Students' Association.—The annual general meeting is called for 7 p.m. on Friday, October 12, at the Finsbury Technical College. The annual dinner will take place at the Engineers' Club, Coventry Street, W.1, on Saturday, November 10, at 6.30 p.m. Mr. W. M. Mordey, the President, will occupy the chair. The balance-sheet is a satisfactory looking document, but the Association's magazine has not been published so frequently as is desirable. Members of the Association should cast aside their apathy and turn up at the annual general meeting.

Educational.—At the present time quite a large number of young men are either arranging for courses of study in electricity or have definitely joined up with certain technical institutes, and in many other cases there may be readers who wish to study quietly at home. In the latter event they will be interested in the advertisement of the Caxton Publishing Co. on September 28, dealing with "The Book of Electrical Installations." This work holds a very high reputation for the practical nature of its contents, and is certain to be well worth the careful consideration of those who may be interested in this particular branch of the science.

Railway Signalling.—Part I., 1923, of "The Proceedings of the Institution of Railway Signal Engineers" has just recently been published, price 7s. 6d. net, and is well worthy of careful perusal by interested readers who are not already members of this particular Institution. In addition to a report of the annual general meeting and presidential address given on February 14 last, it contains reprints of very instructive papers on "Railway Accidents," "Signalling Apparatus for Use in Foggy Weather and Snow on the Metropolitan Railway," and "The Theory of Interlocking," together with quite a number of clear diagrams illustrating the important points referred to in the body of the text. There is also a report on the third annual summer meeting and a complete list of the officers and members of the various grades. Mr. M. G. Tweedie, A.M.I.E.E., the Hon. Sec. of the Institution, is to be congratulated most heartily on its very flourishing condition, much of which is due to the enthusiastic way in which he works on its behalf.

"Experimental Wireless."—We extend a cordial welcome to the new monthly journal under this title, which made its appearance on October 1. The fact that it is issued by Messrs. Percival Marshall and Co., of *Model Engineer* fame, is a voucher that it will be a carefully edited and well-produced publication to which we can wish every success, and the copy now before us gives every promise of a prosperous future in the field which it aspires to cover—viz., wireless experimental and research work. The contents of the first issue include an important article by the Radio Research Board on "The Fading of Signals," and by Mr. E. W. B. Gill, M.A., B.Sc., of Merton College, Oxford, on "The Maintenance of High-frequency Oscillations by Valves." Other interesting contributions deal with "The Uses of Neon Lamps for Wireless," "The Operation and Design of Tuned Anode Receivers," "Efficient Transmission," and "The Measurement of Aerial Resistance." A description of a complete Super-Sonic receiver and an interesting system of speech amplification will be new to many readers. The journal contains 56 pages, and is published at 1s. net by Percival Marshall and Co., 66, Farringdon Street, London, E.C.4.

Social. The first smoking concert of the forthcoming session of the Electro Harmonic Society will be held in the Caxton Hall, Westminster, on Friday, October 12, and we have every reason to believe that the meeting will be well supported, as it always means a happy reunion for old friends.

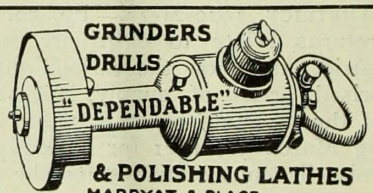
Electric Welding.—A meeting of the Inst. of Welding Engineers will be held at the Holborn Restaurant at 8 p.m. on the 10th inst., at which two papers, one on "Electric Welding" and the other on "Gas Welding," will be read. Tickets of admission can be had on application to the Hon. Secretary at 30, Red Lion Square, Holborn, London, W.C.1.

Appointments Vacant.—The Civil Service Commissioners announce that an open competitive examination in the Engineer-in-Chief's Department of the General Post Office will be held in London commencing on November 6. The age limits are from 20 to 25, with certain extensions. Full details, together with forms of application, may be obtained from the Secretary of the Civil Service Commission, Burlington Gardens, London, W.1.

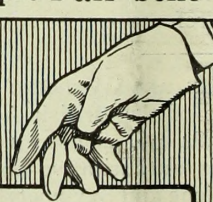
Meetings.—Mr. T. Cooper, M.Inst.C.E., the President-elect of the Inst. of Engineers-in-Charge, will deliver his address to the members at the St. Bride Institute, Bride Lane, Fleet Street, E.C.4, on Wednesday, the 10th inst., at 7.30 p.m., on "Engineering Records and Their Value to the Engineer-in-Charge." Dr. Hele-Shaw in the chair.——The Junior Inst. of Engineers will meet on Friday, the 5th inst. Lecturette, "Design of Underground Cable Systems," by Major A. M. Taylor, M.I.E.E. (slides). Also on Friday, the 12th inst., Mr. W. Yorath Lewis, M.I.Mech.E., will deliver a paper on "The Never-stop Railway" (slides), and on Friday, the 19th inst., lecturette, "The Gas Boiler (or Circulator) and its Application," by F. W. Dye diagrams and demonstrations). All at 39, Victoria Street, S.W., at 7.30 p.m.

Personal.—The Mr. Robert Archer George Read, trading under the name of Read and Partners, at 115, Baker Street, West, who recently met with an unfortunate death, has no connection whatever with Mr. Herbert James Read, the managing director of Read and Partners, Ltd., electrical engineers, of 53, Victoria Street, S.W.1, and of Reading; and Read and Partners, Ltd., have no connection with any other firm of the same name.

Austria.—The report on the Industrial and Commercial Conditions in Austria has just been issued by the Dept. of Overseas Trade, and may be obtained from H.M. Stationery Office, or from ELECTRICITY Office, price 2s. 2d. net, post free. It gives an interesting account of the progress which is now being made by Austria since the finances have been taken in hand by the League of Nations, and should prove of direct value to all British firms who wish to improve their export trade to a country which is now showing steady signs of revival.



Sample Pair Sent on Approval for 8/6



Made of Pure Para Rubber, soft and durable and unaffected by climatic conditions
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A POPULAR SCIENTIFIC WEEKLY JOURNAL
ELECTRICITY
A PRACTICAL TRADE JOURNAL

OCTOBER 12, 1923.

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MORE LIGHT—BETTER LIGHTING.

By the "Osram Baby."

Ever since the introduction of the Osram lamp to the public the makers have devoted much time, thought and money to technical development and improvement of the manufacturing processes, with the result that every year new designs and better lamps have been put on the market. Every year, too, there has been an Osram Publicity Campaign, annually more comprehensive, devoted to the creation of a demand for the Trade to fill. Each campaign has been characterised by some outstanding feature—*e.g.*, the Osram Elephant, the Osram Bird, the Osram Lion, etc. This year we have been presented with the Osram Baby, who first saw the light of day only last month on hoardings throughout the country. It will be agreed that it bears evidence of much careful study as regards detail and colouring, and is a credit to the artist, Mr. Septimus Scott. A pretty picture is of itself useless as an advertising design, which must also convey an idea and by some means or other be talked about by the public. Success in these directions has been attained in the past by most of the Osram designs, and this year the public is concerned as to whether the child is a boy or a girl. In addition no one can deny that the underlying idea is very clever from an advertising point of view. As usual, the design is applied to the whole of this season's Osram advertising, with the object of thoroughly familiarising it in the mind of the public by constant repetition.

Twenty Thousand Posters.

We are informed that no less than 20,000 of these "Ray of Sunshine" posters are being used. They have been produced for the hoardings in two sizes, viz., sixteen-sheet double crown (120 in. by 80 in.) and eight-sheet double crown (80 in. by 60 in.), and are now showing in some 250 separate towns in Great Britain.

Reproductions of the same design have also been provided by the G.E.C. in the form of window bills and showcards for the use of resellers in their shop windows and showrooms to provide a means of linking up with the national posting scheme.

Millions will Read Osram Advertisements.

Another main feature is a comprehensive daily and weekly newspaper campaign, designed to carry the Osram story into the houses, shops, offices and factories of the nation. Regular weekly announcements of substantial size are appearing in the leading London dailies and in some hundreds of provincial papers throughout the lighting season. As with the posters, these Press advertisements recommend their readers to purchase Osram lamps from their local trade dealers, with resulting benefits to the latter.



Fig. 1.—A Selection of Osram Literature.

Reaching the Public at All Hours of the Day.

Other means of publicity for reaching the user include displayed advertisements in magazines and society weeklies, on railway stations, in tubes and tramcars, on theatre programmes, by lantern slides exhibited at cinemas and theatres, electric night signs in the West End of London, and in provincial towns, etc. The keynote to all the advertising and the main theme underlying the whole is the advocation of "More Light" and "Better Lighting."

A very interesting campaign within a campaign was carried out on the eve of the change in daylight hours, when over half a million electric-light consumers received from the G.E.C. on their breakfast table a reminder to put their clocks back, accompanied by a useful little souvenir in the form of an attractive blotter incorporating the new "Osram Baby" design.

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A New Osram Catalogue.

Amongst the material supplied to the Trade this season the most important feature is probably the issue of a new complete Osram catalogue. This publication, a copy of which we have before us, is an entirely new departure in G.E.C. catalogues, not only by reason of the new method (litho offset) which has been used for reproducing the illustrations, but also because it contains information and data regarding electric lamps and lighting, set out in a most clear and easily understood fashion, which should prove of value not only to resellers, but also to all who use the lamps extensively.

The "White Osram."

Another innovation, particulars of which are given in the main catalogue, is the introduction of the "White Osram," a lamp which, it is expected, will find a very large market. It is a gasfilled lamp, the bulb of which has been subjected to a process of spraying during manufacture. The effect produced is that of a standard gasfilled lamp in an opal bulb, but without the disadvantages of the latter. For instance, the light absorption amounts to only 6 per cent.—very much lower than that of a lamp in an opal bulb. Moreover, the price is much less than that of an opal lamp, being only 10 per cent. more than that of a gasfilled lamp with clear glass bulb. The resultant illumination is entirely devoid of glare or dazzle.

The Supply of Folders.

Following their normal practice, the G.E.C. have provided a variety of attractive folders, which they are offering to all recognised resellers, and upon which they print the reseller's name and address without charge. These consist of a folder dealing with standard type Osram gasfilled and vacuum lamps, one



Fig. 2.—The "Osram Baby" Window Centre Piece.

dealing with the "White Osram" lamp, another describing the Osram daylight lamp, another dealing with Osram Candle and Striplite lamps, and other special types, an attractive general propaganda folder, illustrating the colours of well-known racehorse owners, and one of similar nature illustrating the colours of well-known football teams. The discriminate use of these folders by the reseller for local circularising should materially assist in stimulating interest and demand, and the trader cannot but appreciate sales aids of this description.

An Attractive Window Centre-Piece.

There are, in addition, a large number of sales aids, amongst which is a window centre-piece in the form of a box sign, showing a cut-out figure of the "Osram Baby" in the act of switching on the light. We understand that these are supplied to dealers complete with lampholder and three yards of flexible cord and adaptor.



Fig. 3.—"The Osram Bulletin."

The best effect is obtained by the use of a 60-watt "White Osram" lamp, and if a flasher is added a realistic impression of the switching on and off is obtained. These pieces will be distributed to resellers upon application.

Showcards and Window Bills for Window Display.

A variety of different showcards and window bills in different shapes and sizes, enamelled iron swinging signs, enamelled window letters, cut-out counter cards, and other such-like material are included under this heading.

Osram Automobile Lamps.

These find a place in the campaign by the issue of a new folder, giving particulars of the reduced prices and the recent standardised sizes of bulbs. On the back of a new showcard is a complete price schedule and a maximum and minimum stock guide. Advertisements will appear in the motoring papers.

"The Osram Bulletin."

This is a monthly paper devoted to the merchandising of lamps and lighting. The first issue was made on the 1st inst. to all dealers in lamps. It will be issued monthly throughout the lighting season.

Chile.—A report on the financial and industrial conditions in Chile has just been issued by the Department of Overseas Trade, and may be obtained from H.M. Stationery Office or Electricity Office, price 2s. 2d. post free. In it reference is made to the electrification of certain important railways in Chile, as well as to trade conditions generally, and the hope is expressed that British merchants will do their best to develop their trade in this important South American Republic.

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DEVELOPMENTS IN THE ACCUMULATOR SUPERHEATER.

Within the past year or two there has been a great increase in what may be termed standard power station boiler pressures and temperatures of superheat, and to-day modern practice for superstation work is something like 350 lb. and 700° F.

Roughly, the steam consumption of a turbine decreases about 1 per cent. for each 10° F. increase in superheat up to 100° F. From 100-200° F. the beneficial results are then slightly less, being about 1 per cent. for every 12° F. rise, and similarly from 200-300° F. the decrease in consumption corresponds to about 1 per cent. for every 14° F. That is to say, 100° F. superheat reduces the steam consumption of a turbine 10 per cent., and 200° F. 18½ per cent., whilst with a very large amount of superheat, such as 300° F., the figure is 25 per cent., and there is, of course, also the additional advantage of the elimination of the erosion of the blades due to water particles in wet steam.

It must be remembered, however, that these figures do not actually correspond to the reduction in the coal bill at the boiler plant, as the evaporation performance of a boiler is somewhat reduced in proportion as the amount of superheat is increased. The net saving in the coal bill due to superheating is roughly in the case of a turbine about 7½ per cent. for 100° F. superheat, and for 200° F superheat something like 12 per cent.

In connection with the science of superheating it is very interesting to note that Messrs. Daniel Adamson and Co., Ltd., of Dukinfield, near Manchester, well known, of course, for over 70 years past in connection with boilers, superheaters, and various other branches of engineering, including, during the past 20 years the "Rateau" impulse turbine, have now perfected a sectional modification of their accumulator superheater. In both types the ingenious principle is adopted of a wide tube with a central gilled hollow cast-iron core, which splits the steam into five thin layers, and increases the heat transfer, whilst at the same time giving greater strength and an accumulator effect, because the core stores up heat and equalises the normal fluctuations in superheated steam.

In this new "A. B. SECTIONAL" type, the superheater tubes are made from solid drawn, weldless, mild steel, being 4 in. outside diameter and ¼ in. thick, suspended as usual in the flames and hot gases, and connected to 4 in. nipples on the under part of the two top headers by means of a special screwed union joint. The ends of the tubes are also fitted with heavy octagonal steel nuts, screwed to suit the header nipples, so that when these nuts are screwed up, the tubes, which have been staved out by special tools, are forced up against the nipples, a steam-tight joint being made by means of an intervening soft corrugated copper joint ring. In this way also the screw threads being inside the nuts are entirely protected from the action of the hot gases, including grit or scale. The tubes are also "staggered" so as to increase the efficiency of the heat transfer and reduce the resistance to the passage of the gases.

The two headers are circular, being made from 6 in. bore solid-drawn steel tubing with the 4 in. screwed nipples welded on underneath, as already mentioned. Both headers are fitted with flanges bolted on at each end, and the headers also include two 6 in. branches for inlet and outlet steam connections, welded on as usual.

The steam passes down the vertical tube of the loop and is split up by the central gilled core into five narrow divisions, so that the heat transfer is very effective. The steam then mixes again in the loop at the bottom, which is a simple tube without any core, and passes up the other leg, being split up into five parts again, and the design is such that by means of a diaphragm in the header this is repeated twice, once in each half of the installation, giving therefore in addition an extremely uniform superheat.

The whole body of the superheat is carried by a heavy cast-iron carrier frame built up of four pieces (two side and two end pieces), with eye bolts and, when fixed in position, the headers—projecting out of the brickwork—are then provided with an outer sheet steel cover, which can be lagged to prevent undue radiation losses to the air. The installation also includes a spring loaded safety valve of "Niklo" metal body and valve to withstand the highest superheat temperature, two thermometer sockets with thermometers, and is tested to 400 lb. hydraulic pressure, and is undoubtedly a considerable advance in the science of the superheater.

NEW B.E.S.A. PUBLICATIONS.

Specifications No. 116 (1923) for oil-immersed switches and circuit breakers for alternating current circuits; No. 157 (1923) for moulded flat-top insulating bushes; and No. 160 (1923) for slate slabs for electrical purposes have recently been issued by the British Engineering Standards Association.

The specification for oil-immersed switches and breakers completes the series of switchgear specifications, of which there are now seven published, the ratings standardised ranging from 660 to 165,000 volts and 30 to 6,000 amperes.

Much consideration has been given to the question of breaking capacity, and, early in their deliberations, the committee responsible for the preparation of the specifications found it necessary to arrange for extensive experimental work to be undertaken, as there was no information available to enable them to lay down definite specifications for breaking capacity for large sizes. As soon as the British Electrical and Allied Industries Research Association was properly organised this work was referred to them, and research on a large scale has been put in hand. This should prove of the greatest value to the industry, and it is hoped that results will be available in time for the next revision of the specification.

Specifications No. 157 and 160, moulded flat-top insulating bushes and slate slabs respectively, are principally dimensional specifications, and have been prepared by a committee which is engaged on the standardisation of assembled switchgear as a whole and switchboard equipments. It is hoped that the whole industry will adopt these sizes as soon as possible, in order that the full benefits of standardisation work of this nature may be felt quickly.

Specifications for switchboard busbars and connec-

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tions, and the arrangement and marking of busbars, will shortly be issued.

Copies of these publications may be obtained from the offices of the B.E.S.A., 28, Victoria Street, S.W.1, price 1s. 2d. each, post free, or from ELECTRICITY Office.

EXTENSIONS TO BLACKPOOL ELECTRICITY WORKS.

Extensions have been made from time to time to the electricity supply works at Blackpool, and this pioneer station now contains a large amount of quite modern plant. The extensions, inaugurated a few weeks ago, include four water-tube boilers, 250 lb. working pressure and combined steam duty of 150,000 lb. per hour. One of these boilers is of the very latest Spearing type, supplied by the Vickers-Spearing Boiler Co., Ltd.

There is also a new coal-storage hopper, wagon tippler, Telpher equipments, cooling tower, air filters, electric travelling crane, etc., and

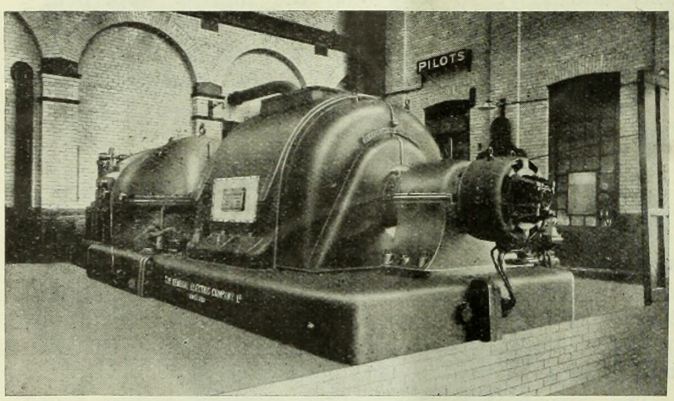


FIG. 1.—6,000-K.V.A. G.E.C.-FRASER AND CHALMERS TURBO-ALTERNATOR SET
(6,600/7,200 volts, 50 cycles, 3,000 r.p.m.)

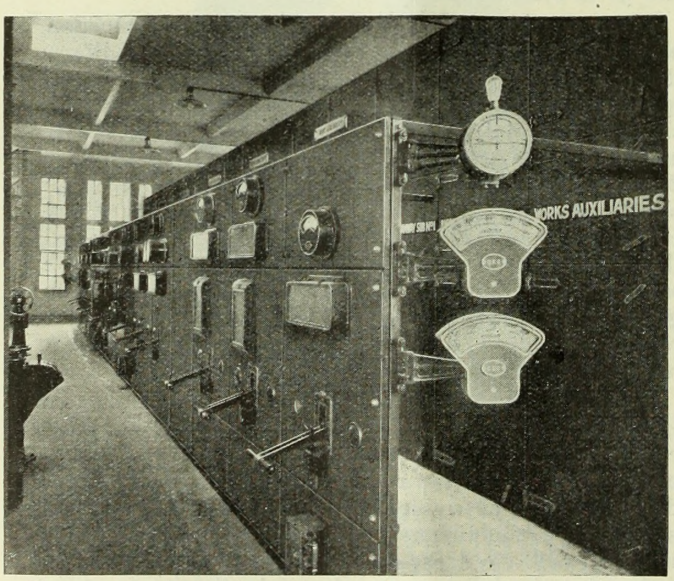


FIG. 2.—MAIN OPERATING SWITCHBOARD. G.E.C. STONEWORK CUBICLE SWITCHGEAR. MECHANICALLY REMOTE CONTROLLED.

Two 6,000-kw. Fraser and Chalmers-G.E.C. turbo-alternators, 6,600 volts, three-phase, 50 cycles.

Two 2,500-k.v.a. phase and frequency changers for converting from 6,600 volts, three-phase, 50 cycles to 2,200 volts, single-phase, 83 cycles, by the English Electric Co., Ltd.

One 1,000-kw. G.E.C. rotary converter for the traction side (550/570 volts). Speed, 750 r.p.m.

New switch room, with switch and control gear, by the General Electric Co., Ltd.

WIRELESS ON A MOTOR-CAR REPAIR LORRY.

One of the latest applications of wireless for purely commercial purposes is on a motor-car repair lorry owned by the Park Motor Co., Ltd., of Wells Street, Jermyn Street, S.W.1. Most satisfactory results are obtained.

A choke-controlled transmitter employing two Marconi valves, and worked from dry batteries, constitutes the sending station, whilst in the receiving set in the van four Marconi valves are used, one of the V.24 type for H.F. amplification and three R type for L.F. and detection, tuned-anode coupling between the H.F. valve and detector being employed.

Apart from the wireless aspect, the lorry is fitted out very ingeniously; benches and tools are carried for wayside repairs, whilst a small two-ton crane is carried to facilitate towing where the breakdown necessitates garage attention. Electrically lighted externally and internally, the lorry carries also several handlamps on flexible cords for use in night repairs. These, of course, are subjected to very rough handling at times, and Osram automobile lamps are used exclusively.

The receiving set is spring-mounted on a table in the lorry, and the aerial is mounted on a telescopic rod. As it is impracticable to have a special wireless operator continuously listening-in, two synchronised watches are employed, and communication is established every quarter of an hour.

Great possibilities are opened up in this direction; already experiments have been conducted with radio-equipped fire engines, and the notion should prove attractive to parcels delivery agencies.

WINDING THE COIL.

Winder: "How on earth do they expect me to wind a coil without a former?"

Foreman: "The other feller used to make his own formers."

Winder: "How did he do it?"

Foreman: "He used to read 'Armature Winding,' by Sylvester. That tells you how to do everything with an armature."

The British Industries Fair.—The D.O.T. states that the voluntary liquidation of the British Industries Fair (Birmingham), Incorporated, in no way affects the London British Industries Fair, organised by that Department; nor will the liquidation of this Association and the transfer of the responsibility for the management of the British Industries Fair (B'ham) to the B'ham Chamber of Commerce prevent the holding of 1924 British Industries Fair at London and Birmingham as usual. The London section will be open at the White City from April 28 to May 9, and the Birmingham section follows on May 12 to 23.

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THE Cable Makers' Association call the attention of manufacturers, sellers and buyers of electric cables to the fact that the letters

C.M.A.

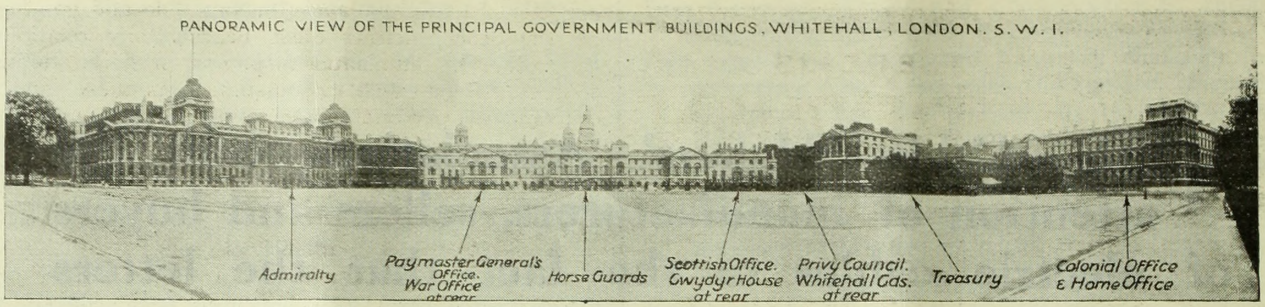
have by Permission of the Board of Trade been registered as a trade mark (Nos. 422219-20-21). This mark is the property of the Association and is usable only by members of the Cable Makers' Association under the authority of the Association. The use of such mark by others on, *or in connection with,* electric cables is an infringement of this trade mark.

Members of the Cable Makers' Association :—

The Anchor Cable Co., Ltd.
British Insulated and Helsby Cables, Ltd.
Callender's Cable and Construction Co., Ltd.
The Craigpark Electric Cable Co., Ltd.
The Greengate & Irwell Rubber Co., Ltd.
W. T. Glover & Co., Ltd.
W. T. Henley's Telegraph Works Co., Ltd.
The India-Rubber, Gutta-Percha & Telegraph Works Co., Ltd.
Johnson & Phillips, Ltd.
Liverpool Electric Cable Co., Ltd.
The London Electric Wire Co. and Smiths, Ltd.
Siemens Brothers & Co., Ltd.
St. Helens Cable & Rubber Co., Ltd.
Union Cable Co., Ltd.
Western Electric Co., Ltd.

Advertisement of the Cable Makers' Association, Sardinia House, Sardinia Street, London, W.C.2.

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Buildings where matters affecting every interest of every person in the Empire are decided. As important, perhaps, as the Houses of Parliament, for in them the decisions of Parliament are put into practice. They are the *Government* Buildings—the buildings of Government, and they are all being

re-wired with HENLEY Cables & Wires

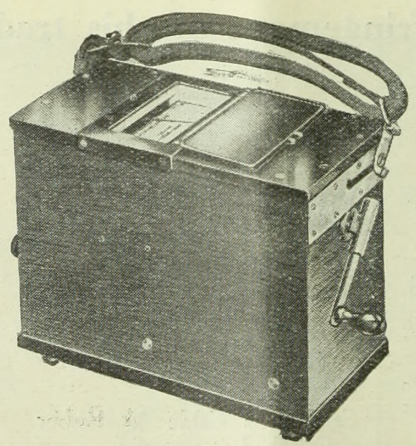
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A TRUE OHMMETER—NOT A VOLTMETER CALIBRATED IN OHMS.

500 VOLT GENERATOR

Scale Zero to Infinity, with clear readings from 10,000 Ohms to 100 Megohms

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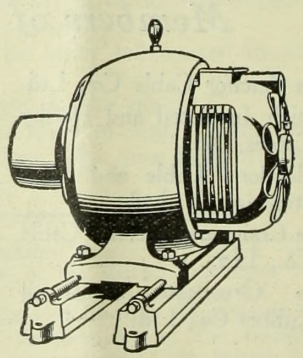
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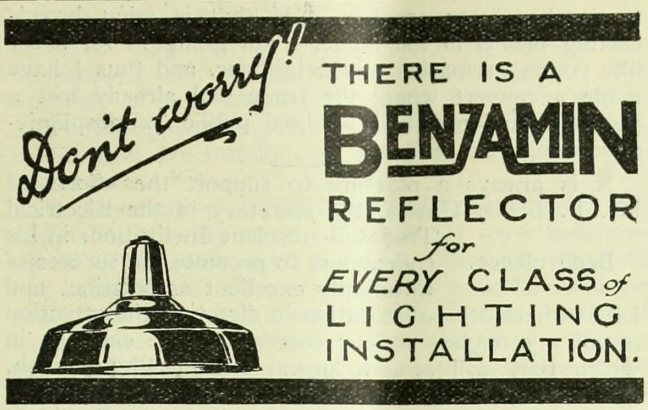
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Advt. of the Benjamin Electric Ltd., Brantwood Works, Tariff Rd., N. 7.

TO OUR READERS.

ELECTRICITY is published every Friday, and, if ordered, is on sale at the principal Railway Station Bookstalls and Newsagents on that day. It has a very large sale throughout the United Kingdom, as well as in the British Colonies and Abroad.

New advertisements for the displayed columns and alterations to existing ones must reach the publishing office not later than first post Tuesday morning, in order to be in time for the issue of the following Friday. This is important. Rate quoted on application. Subscription: 13s. a year, 6s. 6d. half-year, 3s. 3d. a quarter in advance, postage prepaid in the United Kingdom and abroad.

Questions to which an answer is required must be accompanied by a 1½d. stamp for reply. When considered of sufficient interest, the answer will probably appear in the paper.

All remittances payable to the Publishers, S. RENTELL AND CO., LTD., 36-39, Maiden Lane, London W.C. 2. Telephone No. 2460 Gerrard.

Current Topics.

Public Street Lighting.

Those of our readers who have the misfortune to reside in the many towns and urban districts where street lighting still savours of the days of rushlights, will be pleased to learn that, thanks to correspondence and propaganda inaugurated in the columns of our esteemed contemporary, *Municipal Engineering*, there has been formed a new Association of Public Lighting Engineers. This important step was taken on Friday, September 21, at Bingley Hall, Birmingham, during the run of the National Gas Exhibition in that city. The necessary meeting was convened by Mr. C. Chambers-Smith, of London, to whom belongs the honour of thus adding a page to the history of progress in public lighting, for that substantial progress will inevitably result from the co-operation of public lighting officials is a *sine qua non*. The meeting, which was well attended by some of the leading responsible officials from Glasgow, London, Birmingham, Wakefield, Oldham, etc., was unanimous in its condemnation of the present inefficient state of public lighting in most large cities and towns.

As an example of the chaos which prevails at present even in the Metropolis, Mr. W. J. Liberty, inspector of lighting to the City Corporation of London, pointed out that that city's street lighting was under the control of two City Councils (London and Westminster); the London County Council for bridges; H.M. Office of Works for the Royal parks and Government buildings; and twenty-eight Borough Councils. In some cases the borough boundaries ran down the centre of a thoroughfare, and it was not uncommon to find electrically lit public lamps on one side and gas lamps on the other, neither class bearing any relation to each other in illumination, spacing or height of light sources. From such circumstances as these, and the outcome of personal observation, most readers will agree that the new Association has been born at an opportune period, and will find much fruitful ground upon which to exercise its activities. Apparently hitherto public lighting has been nobody's business in particular, and the natural consequence is that the populous centres of the British Isles are amongst the worst lighted towns in the Empire. I wish the new A.P.L.E. every success, and congratulate Mr. Chambers-Smith upon his enterprise in bringing matters to a head.

The E.D.A. Slogan.

In another column we publish the results of the Slogan competition promoted by the Electrical Development Association. The three successful competitors were awarded prizes of £10, £5 and £3 respectively, and we can well imagine that the task of the judges was by no means a sinecure, seeing that nearly 2,000 efforts had to be compared and a suitable selection made. The committee remark on the poor standard of literary ability, ingenuity and imagination displayed by the competitors, and hold that a really apposite phrase containing all the essential elements of a good slogan has yet to be concocted. Unfortunately this lack of originality in slogan composition reflects the inefficiency of our present system of education, already condemned on all sides as costly, wasteful and inefficient. Coupled with the monotonous routine of modern industry, mass production methods, and specialisation in more or less mechanical tasks, our national youth is losing its initiatve. Brains are gradually becoming atrophied, and the present generation of the rank and file are too prone to expect their elders to do all the necessary thinking for them.

Even printers, who should be above such national depreciation or originality, are falling into the rut. Only the other day I entrusted the setting of a new and important catalogue to a first-class firm with many years of experience in similar productions. The draft matter and pulls were most carefully compiled, and meticulous instructions given to the expert representative of the firm, who, however, being an outside man, was only able to pass such instructions on to the chief of the composing room. Here one would naturally expect some display of imagination in the selection of suitable display type, column width, rules, block setting, and general lay-out. When the rough page proofs were forthcoming they might have been set up by an apprentice with a couple of weeks' experience of daily newspaper column printing. There was not the slightest evidence of skill, knowledge or imagination on the part of the compositor responsible, and I had to repeat at considerable length all my previous instructions, as well as make suggestions for the improvement of the production. In other words, I had to teach that printer fully 90 per cent. of the business he had been brought up in. Comment is needless

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Broadcasting.

At last the murder is out, and we all know the Postmaster-General's views on the Advisory Committee's recommendations. In certain respects it does show a child-like faith in the honesty of the trade and the listening-in public. Coupled with the report come appeals to those who have waited events before taking out the necessary licence to cash up, and thereby render themselves immune from legal action as defaulters. We are informed, both through the medium of the B.B.C. nightly announcements as well as by the daily Press, that licences and application forms are obtainable from any post office or branch post office where money orders are sold. As I have just installed a B.B.C. five-valve set, I promptly tried two post offices in succession in my immediate district, only to discover that neither of them possessed either the application forms or the licences. And this after some twelve months of actual broadcasting, coupled with a public appeal to the honesty of the listener-in. What a country; and what an organisation! By walking a mile and a half in pouring rain, I at last managed to locate a postal depôt where they *had* heard of the matter, and were able to produce the necessary document.

Incidentally, as a newcomer to the pastime, and the proud owner of one of the best and most modern outfits it is possible to procure, I am in a position to pass judgment on the progress which has been made both by the leading British radio manufacturers and the British Broadcasting Company. In my capacity as a technical journalist I have had endless opportunities for listening-in both in trade laboratories and at public demonstrations, and I have no hesitation in positively condemning the latter. They are invariably given in the midst of a busy city, with all the consequent interruptions due to trams, electric power circuits, lighting circuits and general electric disturbances. Trade demonstrations at manufacturer's premises are also a wash-out, for the simple reason that the operators are continually experimenting with varied tunings and adjustments, and pay no attention whatever to the selection, duration or stability of the entertainment being broadcasted. Until I had a set of my own, installed in my private residence and under my own control, I did not know what it was to listen to perfect reproduction of broadcasted speech and music.

That my reasoning is correct, and that hundreds of potential customers have been irretrievably lost to the trade by ill-considered public demonstrations of the kind referred to, is borne out by my experience of the changed views of a neighbour. Last year the man was very keenly interested in the subject of wireless, and was prepared to spend £50 on a set for the present winter. During the summer and early autumn he heard three separate demonstrations in his own city, which disillusioned him and entirely put him off the idea of purchasing. On the very first evening I put my set to work I tuned in to the speeches at the Imperial Conference dinner, and in the middle of the toast list called my friend and his wife in to listen. They were both amazed and impressed with the clearness of the production, and sat for an hour listening to speaker after speaker. "If that is what broadcasting means in the home, I am going in for a set like yours," remarked my neighbour, and thus I have made a convert where the trade had already lost a potential customer by ill-judged public "atmospheric-mongering."

Benevolence.

It is always a pleasure to support the efforts of Mr. F. B. O. Hawes, the secretary of the Electrical Trades Benevolent Institution, in his endeavours to promote the success of this really excellent association, and I have therefore no hesitation in directing the attention of all my readers to our correspondence columns in which they will see an appeal by Sir Philip Nash, K.C.M.G., C.B., the chairman of the Metropolitan Vickers Electrical Co., Ltd. He will be the President at the annual festival of the E.T.B.I. to be held on Wednesday, November 14 next, and I hope he will be enthusiastically supported by the trade generally. In the meantime any inquiries on the subject will be willingly answered by Mr. Hawes, whose address is 18, Park Mansions, Vauxhall Park, London, S.W.8.

Elektron.

THE MANUFACTURE OF STEAM.*

By W. E. Highfield, M.I.E.E.

(*Continued from page* 530.)

At this point I should like to emphasise the value of the practice, adopted by many engineers, of letting the boiler-house staff know exactly the results they are obtaining shift by shift. The effect of doing this is to make the men keenly interested in their work, and to cause them to feel that they are doing something essential to the well-being of the undertaking. By posting up in the boiler-house, day by day, the evaporation results obtained by each shift, preferably in the form to which I shall refer later on, the natural sporting spirit of the men is aroused and the healthy desire to continually improve on their previous records generates a spirit of efficiency which has a most happy effect on the relationships between the management and the operating staff. No man, or set of men, can be expected to obtain the best results if they never know what kind of results they are getting, and nothing but good comes from keeping the operating staff fully informed as to the progress of the plant in efficiency and output.

To obtain the figures to which I have referred, it is necessary to have some means of weighing the coal and metering the water or steam on every shift, and it is preferable that measurements should be made in respect of every separate boiler. It is absurd to try to operate a station properly without measuring apparatus in the boiler-room, as it would be to try to do without meters on the switchboard. The apparatus need not be of laboratory accuracy. The average accuracy of the electrical integrating watt-meters which register the amount of power turned out is probably not much closer than about two per cent., and it is, therefore, quite sufficient if the coal and water can be known within the same limits of accuracy. I feel that I cannot lay too much stress upon the necessity of weighing or measuring the

* Presidential address before the N.A S.E., September, 1923.

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quantity of coal and water used per shift. It is so essential that one can say that no boiler-house can be properly run without these measurements. The question is not whether the cost of the necessary measuring apparatus can be afforded. The point is rather that no station can afford to be without the apparatus.

An examination of boiler-houses in this country will show that not only are the facilities for these measurements often inadequate, but that frequently they do not exist at all. Money has often been lavished on subsidiary apparatus, but the main factors, coal and water, have been neglected. The analogy of a factory can again be applied. In what sort of a position would a factory be if it took no proper precautions to discover the cost of the goods it made? Not the average cost over, say, a year, but the exact cost. It would simply relapse into bankruptcy. It is equally important for an electric supply company to know the cost of its product.

In particular must the small station be regarded, because there are so many small stations, and because there will continue to be a large number of small stations. The small station can be as relatively efficient as the large station, and an all-round improvement in the small stations would make such a great difference to the all-round efficiency of the stations considered as a whole. According to the Commissioner's summary there are 352 stations each generating less than 25 million units per annum. Some of these stations generate under 50 thousand units per annum. The total units generated by all these stations is approximately one-third of the total units generated by all stations, viz., 1,700 millions out of 4,732 millions. That brings out the importance of the efficiency of the small station to the country. The average annual fuel consumption per unit generated varies from 3.38 lb. to 20.9 lb. These figures are quoted to show the importance of the coal and water measuring instruments and to what enormous totals the figures run to in the aggregate.

Returning now to the measurement of the coal and water to each boiler, there are several ways of doing this, and the method is immaterial as long as the results are obtained.

These measurements form the basis of the whole boiler-house system. Other instruments are necessary or desirable, but they are subsidiary in the sense that they give the engineer the necessary indications as to why he is not getting the full efficiency of the plant as shown by the coal and water measurements. Before considering other measurements that may be desirable, it is appropriate to consider here how many records the staff of the station can deal with. It is quite possible to put in so many instruments, both direct reading and recording, that it is impossible for the staff to properly analyse the results obtained. This is quite a serious matter, because it has a moral influence on the staff and the value of the measurements is apt to fall into contempt. I put forward a strong plea for simplicity and for concentration on essentials. In a very large station a large staff for dealing with such records may be kept, but in a small station this is not so, hence the importance of only dealing with the absolutely essential measurements as a matter of routine.

Presuming, then, that the boiler-house is equipped with apparatus for ascertaining the basic figures of operation, namely, the pounds of coal burnt and the pounds of water evaporated during every shift, we have next to see what use can be made of these figures. For unless data are used for some practical purpose their collection is a mere waste of time. I hold it, indeed, a fundamental rule in connection with power plant matters that no statistics are worth recording unless they can be made the basis of some action, either at the time or later.

The obvious thing to be done with the coal and water figures is to calculate the evaporation obtained per lb. of coal. This, indeed, is done in every power station. But when the results are examined, a considerable variation will be noticed. Every station engineer knows that the greater the output, the greater in general will be the evaporation figure, and it soon becomes evident that the effect of the variation of the output may be quite sufficient to mask important variations in operating efficiency. A direct comparison between the evaporation figures would, therefore, be misleading unless this fact were taken into account. It is the operating efficiency which we are concerned to know, and some means must be found of allowing for the effects of different outputs if the figures are to have any useful significance.

To make this important point as clear as possible I will consider an actual case in which the electrical output during three consecutive shifts was 50,000 kw.h., 100,000 kw.h., and 200,000 kw.h. respectively. The corresponding coal consumptions were respectively 105,800 lb., 191,600 lb., and 363,200 lb., while the corresponding water consumptions were 676,750 lb., 1,253,500 lb. and 2,407,000 lb. on the three shifts. From these figures we find that the evaporation on the first shift was 6.367 lb. of water per lb. coal, 6.542 lb. on the second, and 6.627 lb. on the third shift. The difference, as will be seen, is quite material, and it is in no way due to any difference in operating efficiency, but it is entirely brought about by the variation in the output.

In order that the operating efficiency of any shift may be determined, regardless of the output, so that the performance on any shift can be usefully compared with that on any other, a very simple method of dealing with the results was devised some years ago by Mr. R. H. Parsons, who was at the time the engineer and manager of a large station abroad. As I am to-night dealing only with the boiler-house, I will merely explain that part of the method which concerns my subject. A piece of squared paper is obtained and a scale of ordinates marked off in pounds of coal burnt per shift, the base being similarly marked off in lb. of water evaporated per shift. The performance during any shift can obviously be represented by a dot on the chart, this dot being drawn at a distance above the base line equal to the number of lb. of coal burnt, and at a distance to the right of the margin equal to the weight of water evaporated. By recording the performances of a number of shifts in this way a series of dots are obtained which, it will be observed, lie in a slanting direction across the chart. The line which lies most evenly among the dots is drawn in, and this line becomes the criterion of performance of the station. If, at the end of any shift, the dot corresponding to the performance lies above the line, then

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more coal was burnt during that shift than should have been consumed to evaporate the particular quantity of water used.

In the example I have taken above, if the coal and water per shift are plotted in the manner described, it will be found that the three performances fall exactly on the line represented by the equation $C = 5123 + 0.1487\ W$, and they are, therefore, of exactly equal merit, in spite of their apparent discrepancy. This equation may also be written in the form $W = 7.647\ C - 42{,}217$, and from it we notice two facts. Firstly, were no water to be evaporated, 5,123 lb. of coal per shift would be required to keep up steam and to neutralise the losses by radiation, etc., in the boiler-room, and, secondly, that the evaporation is approaching a limiting figure of 7.647 lb. of water per lb. of coal as the output per shift increases.

A similar line and a corresponding equation may be obtained connecting the quantity of coal burnt with the electrical output, and from these three relationships a lot of most useful and interesting deductions concerning the station can be drawn. I will not now enter into a discussion of these, but will merely emphasise the fact that, even without analysing the meaning of the equations, the Parsons lines make it possible to see at the end of every shift exactly how the performances of the boiler-room and engine-room have compared with the standard performance, and they give this information definitely and in time for immediate steps to be taken to remedy any lapse of efficiency which may be disclosed. The method is applicable to power stations of every size and type, and has been adopted by some of the most important ones in the country. I commend it to your notice as being the most practical means I know of deriving immediate benefit from the coal and water records of the station.

(To be continued.)

UNDERGROUND CABLES FOR HIGH-TENSION SUPPLY.

The Birmingham and District Electric Club held the first meeting of the autumn session on Friday, September 28, when Major A. N. Taylor, M.I.E.E., gave a lecture on this very interesting subject, in the course of which he stated that the problem of the transmission of power in great bulk had been intensified by the growing size of power stations, the need of linking such stations and electrification of railways. As a matter of opinion, he believed that the limits in mere sizes of cables had already been reached. Major Taylor gave an interesting and lucid résumé of his paper read before the Institution of Electrical Engineers, in which he claimed that, by using a special cable, consisting of a central core and two copper intersheaths connected to the terminal transformers on an ingenious six-phase system, cables of quite ordinary dimensions could be safely used to carry underground pressures in the region of 150,000 volts, and this without adding to the present insulation difficulties.

He claimed that the saving of copper and lead sheathing on such a system would be such as to have a very appreciable effect upon the economic distribution of power over large areas.

B. E. X.

Work has now been started on the electric power station which is to supply the Exhibition with power and light. It will be one of the exhibits in the Electrical and Allied Industries Section of the Palace of Engineering, and a gallery is being built from which visitors will be able at all times to view the machinery (for which the B.E.A.M.A. are responsible) at work. The main features will be three 1,500-kw. turbo-generators, fed from two types of water tube boilers. Each item of plant will be the work of a different firm.

For purposes of demonstration, a very important section of the industry is showing other forms of power producers. In the main hall, though not actually in the power station, there will be exhibited a slow-speed steam set and a horizontal internal combustion set, each generating 300 kw. These will be run under load, and will be coupled up to the body of the plant through panels on the main switchboard.

The whole of the electrical and allied engineering section has been organised by the B.E.A.M.A., and the area covered is $4\frac{1}{2}$ acres, some of the 200 concerns exhibiting having taken as much as from 4,000 to 8,000 sq. ft. for their stands.

ELECTRICAL ENGINEERING—FINAL GRADE.

SOLUTIONS TO 1923 EXAMINATION QUESTIONS OF THE CITY AND GUILDS INSTITUTE.

BY EDWARD HUGHES, B.Sc. (Eng.), A.M.I.E.E.

(Continued from page 474.)

Q. 7.—A 1,000-kVA and a 500-kVA single-phase transformer are connected to the same bus-bars on the primary side. The secondary pressures at no-load are 500 and 510 volts respectively. The impedance voltage of the first transformer is 3.4 per cent. and of the second 5 per cent. What cross-current will pass between them when the secondaries are connected together in parallel?

Assuming that the ratio of resistance to reactance is the same in each, what currents will flow in the secondary windings of the two transformers when supplying a total load of 1,200 kVA?

A. 7.—Since no primary voltages are specified in question, we shall consider only the secondary voltages; thus, if 500 and 510 volts respectively were applied to the low-tension windings of the transformers with the high-tension windings on open circuit, the voltages induced in the latter would be equal. Further, if the H.T. windings were short-circuited, the voltage to be applied across the L.T. winding to set up full-load current would be $\frac{3{\cdot}4}{100} \times 500 = 17$ volts for the 1,000-kVA transformer, and $\frac{5}{100} \times 510 = 25.5$ volts for the 500-kVA transformer. But the current in the former would be double that in the latter, so that if the equivalent impedances of the two transformers, referred to the

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L.T. side, be Z_1 and Z_2 respectively, and if I_1 and I_2 be the respective full-load currents, then—

$$Z_1 = \frac{17}{I_1}, \text{ and } Z_2 = \frac{25.5}{I_2}$$

$$\therefore Z_1 + Z_2 = \frac{17}{I_1} + \frac{25.5}{I_2} = \frac{17}{2I_2} + \frac{25.5}{I_2} = \frac{34}{I_2}$$

$$\text{But } I_2 = \frac{500 \times 1{,}000}{500} \text{ (approx.)} = 1{,}000 \text{ amps.}$$

$$\therefore Z_1 + Z_2 = \frac{34}{1{,}000} = 0.034 \text{ ohm.}$$

When the two transformers are connected to the same bus-bars on the primary side and their secondaries are connected in parallel, the resultant voltage in the latter $= 510 - 500 = 10$ volts.

$$\therefore \text{Circulating current in secondaries} = \frac{\text{resultant voltage}}{\text{sum of the equivalent impedances}} = \frac{10}{0.034} = 294 \text{ amperes}$$

The power-factor of the load in the second part of the question is not specified; for simplicity, it will be assumed to be unity. In the absence of more specific data, a sufficiently approximate solution is obtainable by first finding the currents that would be supplied by each transformer if the e.m.fs induced in each secondary were equal, and then calculating the resultant currents by superimposing on the respective load currents the circulating current (already calculated) due to the difference of 10 volts in the secondary e.m.fs.

Figure 10 shows the equivalent circuits of the two transformers having equivalent impedances of Z_1 and Z_2 respectively. Now, since the ratio of the resistance to the reactance is the same for each transformer, the currents through the transformers will be inversely

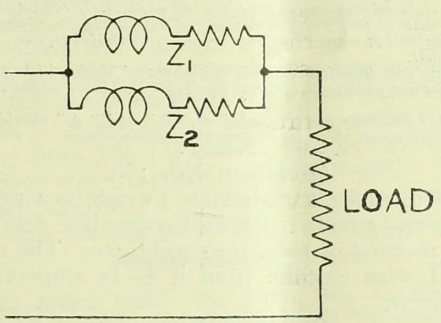


FIG. 10.

proportional to their impedances, and the load current will be the *arithmetic* sum of the currents through Z_1 and Z_2.

If the load voltage be assumed about 500, then full-load current $= \frac{1{,}200 \times 1{,}000}{500} = 2{,}400$ amps.

Also, it has already been shown that

$$Z_1 = \frac{17}{I_1}; \; Z_2 = \frac{25.5}{I_2}; \text{ and } I_1 = 2I_2.$$

$$\therefore \frac{Z_1}{Z_2} = \frac{17}{2I_2} \times \frac{I_2}{25.5} = \frac{17}{51} = \frac{1}{3}$$

Hence current through $Z_1 = I_1$

$$= \frac{Z_2}{Z_1 + Z_2} \times \text{total current}$$

$$= \frac{3}{4} \times 2{,}400 = 1{,}800 \text{ amps,}$$

and current through $Z_2 = I_2 = \frac{1}{4} \times 2{,}400 = 600$ amps

In the actual transformers, however, the secondary e.m.f. in the second transformer is 10 volts greater than that in the first, so that a circulating current I_c of 294 amps is set up lagging behind the *resultant* e.m.f. by an angle ϕ, the value of which depends upon the ratio of the reactance to the resistance of the windings. Taking this ratio as 4, say, for transformers having the percentage impedance voltages given in question, we have—

$$\tan \phi = 4$$
$$\therefore \phi = 76^\circ \text{ (approx.)}$$

If the slight phase difference between the load current (at unity P.F.) and the secondary induced e.m.f. be neglected, we can represent the currents in Z_1 and Z_2 by vectors as in Figs. 11 and 12. In Z_2 the resultant current I_b is the vectorial sum of I_2 and I_c, whilst the

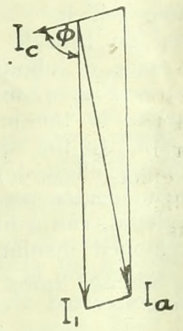


FIG. 11.

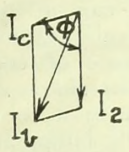


FIG. 12.

resultant current I_a in Z_1 is the vectorial difference between I_1 and I_c.

$$\text{But } I_b^2 = I_2^2 + I_c^2 + 2I_2 I_c \cos 76^\circ$$
$$= (600)^2 + (294)^2 + 2 \times 600 \times 294 \times 0.242$$
$$= 531{,}700$$
$$\therefore I_b = 730 \text{ amps.}$$

= secondary current in the 500-kVA transformer.

$$\text{And } I_a^2 = I_1^2 + I_c^2 - 2I_1 I_c \cos 76^\circ$$
$$= (1{,}800)^2 + (294)^2 - 2 \times 1{,}800 \times 294 \times 0.242$$
$$= 3.07 \times 10^6$$
$$\therefore I_a = 1{,}750 \text{ amps.}$$

= secondary current in the 1,000-kVA transformer.

Had the load been at a P.F. other than unity, the phase difference in the load circuit would have had to be deducted from the angle of 76° assumed above when calculating I_a and I_b.

(To be continued.)

Faraday House O.S.A.—We understand that the fifteenth annual dinner of the Faraday House Old Students' Assoc. will be held at the Hotel Cecil on Friday, 19th inst. Mr. H. W. Miller, M.I.E.E., will be in the chair, and there is sure to be a large attendance. Members of the Association may introduce guests, who need not necessarily be Faradians. A musical entertainment will, as usual, follow the dinner, and old students who are desirous of attending should make early application for tickets to the Secretary, Faraday House, Southampton Row, London, W.C.1.

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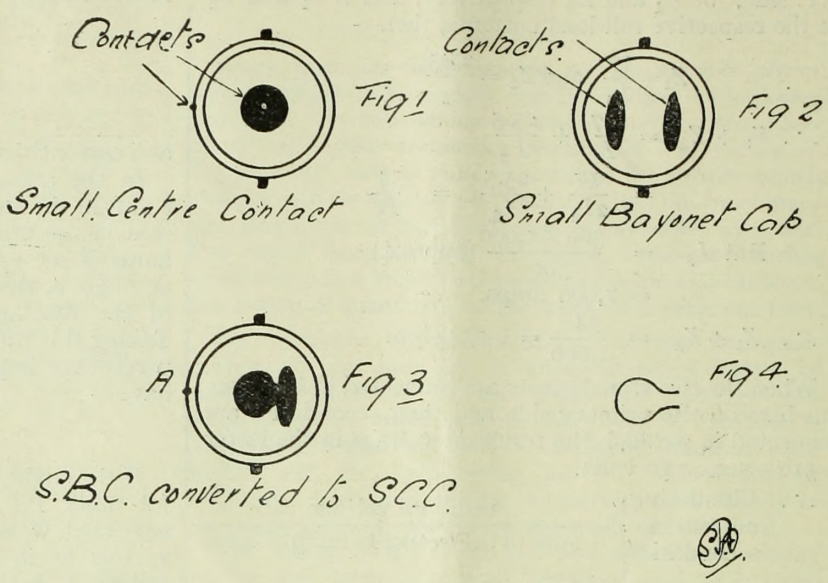
CONVERTING MOTOR-CAR LAMPS.

By S. J. Berryman.

It not being always possible to procure the correct type of lamp required, perhaps the following tip will be of interest to car drivers whose vehicles are fitted with an electric lighting set.

As the lamps used on a car were of the small, centre-contact type, and the only style obtainable in the district were the small bayonet cap, it became necessary to convert the latter to the former for a case of immediate use.

The alteration was made in the following way: first scrape away the insulating material around one contact of the small bayonet cap lamp, and after disconnecting one of the leading-in wires from its contact, solder it to the metal part at the top of the lamp as at A, Fig. 3, or bring this wire through the cap at the hole which holds the insulating material on the side of the cap.



Bend a piece of copper wire of about 22 or 24 S.W.G. to the shape shown in Fig. 4, and let it set down a little in a recess made in the insulation on the top of the lamp, and solder to the opposite contact, a little of the solder being allowed to run over the copper wire, filling up the centre piece.

After the soldering is completed, run a little sealing-wax in the place of the removed insulating cement at the first contact and the conversion is complete.

Several lamps have been converted this way and all proved a success.

ELECTRICAL STORAGE-BATTERY LOCOMOTIVE £1,000 PRIZE COMPETITION.

Lieut.-Colonel G. R. Lane-Fox, M.P., Secretary for Mines, announces that, in order to encourage the production of a safe and efficient type of electrical storage-battery locomotive for use underground in coal mines, and with a view to displacing pit ponies in deep and hot mines, Mr. Charles Markham, colliery director, of Ringwood Hall, Chesterfield, has placed at his disposal the sum of £1,000 to be offered as a prize for the best vehicle which fulfils certain specified conditions.

Mr. J. A. B. Horsley (H.M. Electrical Inspector of Mines), Mr. Sydney Bates (Institution of Mining Engineers), Mr. Roslyn Holiday (Mining Association of Great Britain), Mr. Roger Smith (Institution of Electrical Engineers) and Mr. Herbert Smith (President of the Miners' Federation of Great Britain) have consented to act as judges, and with the co-operation of H.M. Inspector of Mines have drawn up the conditions of the competition.

The competition will be open to manufacturers of any nationality on the first day of October, 1923, and will be closed on such a date not less than six calendar months thereafter as the judges may determine. Working trials, in England, will subsequently be arranged of any vehicles which are selected for test.

Copies of the conditions of the competition can be obtained on application from Mr. A. M. Clegg, Secretary, Electrical Storage Battery Locomotive Competition, Mines Department, Dean Stanley Street, London, S.W.1

Questions and Answers by Practical Men.

RULES.

Questions: *We invite our readers to send us questions, preferably on technical problems that have arisen in actual practice. Questions which we consider of sufficient interest to our readers will either be replied to under "Answers to Correspondents" or replies will be invited from our readers. One shilling will be paid for the question which we select for competitive replies in this column.*

Answers: *A fee of 10s. will be paid for the answer which we consider shows the greatest merit, and 5s. for the one we select as second best. In judging the replies, importance will be attached to clearness and conciseness, as well as accuracy. The Editor reserves the right to make no award, or to accept only one reply, if, in his opinion, the answers received do not possess sufficient merit. Competitors desiring the return of their manuscripts, if unaccepted, should enclose stamped addressed envelope.*

Write on one side of the paper only, and if diagrams are sent, draw them on a separate sheet of paper attached to the manuscript. Competitors may adopt a "nom de plume," but, both in the case of questions and answers, the competitor's real name and address must be sent with the manuscript as a guarantee of good faith. No correspondence will be entered into with regard to successful replies. The Editor's decision is final.

Commencing with Question No. 101, a Diploma of Merit will be awarded to the six competitors who win the first or second prize the most times during the next twelve months.

The words "Questions and Answers" or "Q" and "A" should be placed at the top left-hand corner of all letters intended for this column.

Question No. 169.

I wish to make a resistance to reduce a pressure of 200 volts to 25 volts. I would appreciate details of size of wire, method of mounting coils, etc. The maximum current I wish to take from it is 15 amperes.—J. R. Woodhatch.

Question No. 170.

I desire to make a testing board suitable for testing motors, elements, etc. The supply is 200 volts. Can any reader tell me what instruments and apparatus I shall require, and method of mounting?—J. R. Woodhatch.

(*Replies to Questions Nos. 169 and 170 must be received not later than October 27, 1923.*)

The Institute of Metals.—The Inst. of Metals has just issued its programme of meetings and lectures for the Session 1923-24. Some of them are of a character to interest electrical engineers, including "Metals for Lamp Manufacture," "X-Rays and Metallurgy," "Electric Resistance Furnaces," and "Substitutes for Platinum."

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E.D.A. SLOGAN COMPETITION.

The Special Committee appointed by the E.D.A. to adjudicate in the recent Slogan Competition has now completed its work.

Nearly 2,000 slogans were submitted by 194 competitors, and the following phrases have been selected as most closely meeting the requirements; prizes have been awarded as follows:—

(1) *"Just Touch That Switch."*
Prize of £10 awarded to:—
Mr. E. A. Joyce,
The Cherubs,
68, Englewood Road,
Clapham Common, S.W.12.

(2) *"Electrify and Troubles Fly."*
Prize of £5 awarded to:—
Miss M. I. Dewdney,
3, Cranbrook Park,
Wood Green, N.22.

(3) *"The Right Way—The Electric Way."*
Prize of £3 awarded to:—
Mr. A. C. Bostel,
Electricity Showrooms,
3, Park Lane, Croydon.

The task of arriving at these decisions was not an easy one, and the Committee feel bound to state that on the whole the standard of literary ability, ingenuity and imagination displayed was very disappointing, and that a phrase containing all the essential elements of a good slogan has yet to be produced.

It is not an easy subject by any means, and it may be consoling to competitors to know that this lack of ability to produce a really good slogan is felt as much by our contemporaries on the other side of the Atlantic as in this country.

A slogan is neither the most nor the least important feature in advertising. Many thousands have been created for various commodities, but rarely one which can be regarded as a total eclipse.

The electrical slogan which will most nearly approach the standard will contain a general reference to the industry and not to any particular application of it, it will contain a word such as "Electricity," "Electrify," "Switch" or something similar in order to make its meaning quite clear, it will not suggest the curtailment of anybody else's business, such as "gas," "coal," or even the "doctor," it will be brief, human and definite.

We wait for the *immortal* who can produce it.

Siemens Sports Club.—The Town Hall at Woolwich was crowded by an enthusiastic audience on Wednesday, the 3rd inst., when a concert was given by the Siemens Sports Club, followed by the distribution of prizes. The musical items were of a high order, and were beautifully rendered by the artistes, which included Miss Gladys Glyn, Miss Connie Marshall, Messrs. Bert Clevely, Bert Hughes, Harold Knowlton, Harry Roberts and Issaye Schlaen. The prizes were distributed by Gen. Sir Hubert De La Poer Gough, G.C.M.G., K.C.B., K.C.V.O., one of the directors of Siemens Brothers and Co., Ltd. Mr. M. A. Stapley, speaking on behalf of the Sports Club, thanked Sir Hubert for his kindness in attending that evening, which was evidence of the interest taken by the directors in the welfare of their employees. In reply, Sir Hubert expressed his pleasure of being afforded the opportunity of participating in this pleasant event, and, in the course of his speech, remarked that sport was good for everyone, as it taught its devotees not only how to win, but, what was often of even greater importance, how to lose.

Trade Notes.

"Pointers on British Automatic Telephony" is the apt title of a booklet issued by the **Relay Automatic Telephone Co., Ltd.** (Marconi House, Strand, W.C.2). It deals with the system for inter-departmental use, and refers to the Government and commercial installations supplied to date.

Crompton and Co., Ltd. (Chelmsford), have produced an excellent brochure dealing with power-factor improvement on polyphase A.C. systems from the technical and commercial points of view. The Auto-Synchronous motor for this purpose, as developed and supplied by the firm in large and small sizes, is fully dealt with and its advantages carefully summarised.

Leaflets from **Automatic and Electric Furnaces, Ltd.** (Elecfurn Works, 173-5, Farringdon Road, E.C.1), deal with (1) their new patent radiant heat furnaces for tempering, carbonising, vitreous enamelling, japanning and annealing, and (2) their new furnaces for hardening high-speed steel.

A complete set of castings, forgings, nuts, keys, shafts and full-size drawings necessary for the construction of the 1½ B.H.P. "Universal" two-stroke petrol or gas engine is supplied by the **Universal Motor Co.** (St. James's Road, Derby), who also supply this popular little engine in the finished state. Particulars and prices are contained in a leaflet which interested readers should apply for at once. The firm also supply a cheap efficient paraffin vaporiser for converting internal-combustion engines from gas to paraffin fuel. It is listed in sizes from ¼ B.H.P. to 8 B.H.P.

Two new attractive coloured showcards have been produced by the **G.E.C.**, and are now available for traders. The first of these advertises "Gecophone" headgear telephone receivers of both the headband and lorgnette types. The other showcard, featuring Marconi valves, embodies the "Wireless Wonder" figure so familiar in the G.E.C. valve advertisements. We understand that copies of these showcards will be sent gratis to all trade applicants.

A new instrument catalogue is to hand from **Johnson and Phillips, Ltd.** (Charlton, S.E.7). Illustrations and particulars are given of many patterns of M.I., hot wire and M.C. ammeters and voltmeters, also long scale induction ammeters and voltmeters. For H.F. current measurement such as in aerial circuits where the ordinary type of hot wire instrument is not available, the hot strip ammeter is available.

From the **British Insulated and Helsby Cables, Ltd.**, of Prescot, we have received a copy of Pamphlet P.183, which deals with the Prescot Mistake Proof Switch Cut-out. It is a type of instrument which will be of direct interest to all our installation contractor readers as well as to engineers-in-charge of plant, etc.

We have received from the **General Electric Co., Ltd.** (Magnet House, Kingsway, W.C.2), a copy of their new export catalogue of Osram lamps. The first few pages are occupied with concisely stated conditions of sale, followed by standard shipping specifications detailing net and gross weights, sizes, etc. Particulars and illustrations of the standard method of packing follow, whilst another useful page is that devoted to full-size illustrations of lamp caps. The catalogue proper gives dimensions and particulars of all standard Osram lamps (gasfilled and vacuum types). Automobile lamps and Osglims are also included, as well as Robertson carbon filament lamps.

The **London Electric Firm**, Brighton Road, Croydon, have purchased from Messrs. The Jeary Electrical Co., Ltd., of 8, Lambeth Hill, E.C., the remaining stock of "Braulik" winches, contact devices, arc lamps, transformers and spare parts, etc., and are therefore in a better position than ever to deal with all problems connected with lamp lowering. This purchase consolidates further their twenty years' unbroken practice in this branch of the electrical art.

A new catalogue (No. 114) has just recently been issued by the **Hart Accumulator Co., Ltd.**, of Stratford, London, E.15. It deals with the latest types of "Hart" batteries for radio-wireless, telegraph and telephone systems, and gives excellent illustrations thereof, as well as clear details of the dimensions, capacity and prices. It will therefore prove of direct interest to all firms who specialise in the supply of wireless goods to the ever-growing army of amateurs, and as such should be obtained by them without delay. It is certain to assist business.

A card dealing with the Cambridge Projection Unipivot galvanometer for lecture purposes has been issued by the **Cambridge and Paul Instrument Co., Ltd.**, of 45, Grosvenor Place, S.W.1. Readers who desire further particulars should write to the company and ask for a copy of List No. W.160.

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Correspondence.

THE ELECTRICAL TRADES BENEVOLENT INSTITUTION.

To the Editor of ELECTRICITY.

SIR,—I venture to put before you the claims of this Institution and to ask you for your generous support.

The principal object of the Institution is to grant pensions, which are paid out of the dividends on the investments. As the income from the investments is under £800 per annum, it is obvious that only a very limited number of pensions can be given unless the invested funds are materially increased.

In addition to the granting of pensions, the Institution gives temporary assistance to those in the electrical industry coming within the scope indicated in the heading of this letter. Up to the present, every qualified person who has applied for temporary relief has been assisted, and during the past twelve months the amount required and expended in this direction has much exceeded that of any other year.

I therefore ask for your help to enable us to maintain the position of being able to make grants to all those applicants who are qualified to receive such help, and also to assist us in making the invested funds sufficiently large to meet the demands when pensions are required.—Yours faithfully,

P. A. M. NASH.

Various Items.

The Electro-Harmonic Society.—The first smoking concert of the season will be held in the Caxton Hall, Westminster, to-night (Friday, 12th inst.), at 8 o'clock. Chairman, Maj.-Gen. Sir Philip Nash, K.C.M.G.

The Osram G.E.C. Fire Brigade.—The Osram Works Fire Brigade have won the contest for 5 men, open to the United Kingdom, which was held under the auspices of the London Private Fire Brigades' Association. The Osram Lamp Works Fire Brigade are also the holders of the Corporation of London Silver Shield for Private Fire Brigades.

Trade Catalogues Required.—H.M. Trade Commissioner in the British West Indies (Mr. J. L. Wilson Goode), 10, Broadway (P.O. Box 225), Port of Spain, Trinidad, would be glad to receive for purposes of reference and display in his office, copies of up-to-date catalogues of British productions, in order that he may be in a better position to further British trade in the West Indies.

I.E.E. Informal Meetings.—The following informal meetings will be held at the Institution at 7 p.m.:—November 5, "Engineering Training"; November 19, "Power in Telephone Exchanges"; December 3, "Electrical Apparatus for the Deaf." Dr. A. Russell (President) will open the discussion on November 5, Mr. A. B. Eason on November 19, and Mr. C. M. R. Balbi on December 3.

The Shipping Depression.—We are now experiencing the first shipping depression during which it has been possible to determine the respective merits of motor ships and steamers under adverse conditions. According to *The Motor Ship*, the result has been a triumphant vindication of the economy of the oil-engined vessel, with the consequence that the proportion of new orders for motor ships to those of steamers has risen in a few years from 10 per cent. to 60 or 70 per cent. It cannot be too strongly emphasised that this remarkable change is the direct effect of the experience that has been gained by shipowners during a period when the difficulties encountered have been greater than ever before in the history of shipping. It is, therefore, considered that the industry concerned with motor-ship construction has little to fear from the future if present troubles can be tided over, but for steam shipbuilding the outlook is by no means so satisfying.

Wireless in Russia.—U.K. firms who are interested in wireless in the Soviet Republic are informed that an important decree has recently been issued by the rulers of that State dealing with the construction and exploitation of wireless stations for commercial, industrial, educational and scientific apparatus, and also in regard to amateur wireless stations. A translation of the decree may be seen at the D.O.T. (Room 52), 35, Old Queen Street, London, S.W.1.

E.D.A.—In the programme of the E.D.A. Salesmanship Conferences, London Area, Session 1923-24, the meeting for April 11 was left blank. This has now been filled. Mr. B. Longbottom, M.I.E.E., will be chairman, and Mr. W. Y. A. Anderson (B'ham Electricity Supply) will read a paper on "Selling Electric Power."

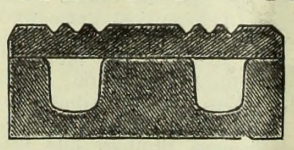
Diesel Engine Users' Association.—At the first autumn meeting of the Diesel Engine Users' Assocn., which was held at the I.E.E. on the 5th inst., Mr. K. B. Wood Smith submitted some notes on comparative running costs during the year 1923 of steam and Diesel driven pumping plants used in connection with the public supply of water at Alexandria, Egypt. The comparison was decidedly interesting as showing the economies to be effected by the substitution of Diesel for steam driven pumps in water works where pumping was continuous throughout the 24 hours.

Manchester Wireless Society.—This Society, which is affiliated with the Radio Society of Great Britain, and has its headquarters at Sorrell Bank, Pendleton, Manchester, is running two series of lectures throughout the season. One is of the popular and advanced type, and the other elementary. Wireless sets are at the disposal of members, and on Wednesday nights questions will be answered. Judging by the syllabus, the arrangements, coupled with the subjects of the lectures, should ensure a large increase in membership. The Hon. Sec. is Mr. Y. W. P. Evans.

Meetings.—The annual general meeting of the Inst. of Production Engineers will be held at 7.30 p.m. on Wednesday, the 17th inst., at the Engineers' Club, Coventry Street, London, W.1, when Mr. J. D. Scaife, President for 1923-24, will deliver his presidential address, which will be followed by a smoking concert.——The Junior Inst. of Engineers will meet on Friday, the 12th inst., when Mr. W. Lewis, M.I.Mech.E., will deliver a lecture on a new system of transport known as the "Never-stop Railway," and on Friday, the 26th inst., when Mr. A. V. Ballhatchet will lecture on "Crystals for Wireless Reception." Both meetings at 7.30 p.m. at 39, Victoria Street, S.W.1.

Plant Wanted.—The N.S.W. Govt. Rlys. and Tramways invite tenders for rotary converter units.——The Municipal Council of Sydney also invite tenders for high tension split conductor feeder panels.——The City of Toronto is inviting tenders for the supply and delivery at the main sewage pumping station of one horizontal centrifugal pump direct connected to a 220-volt 3-phase motor mounted on a truck, together with suction and discharge piping valves, A-frame, etc., complete and ready for operation.——The P.M.G.'s Dept., Sydney, invite tenders for protective electrical apparatus. It also invites tenders for telephone apparatus and parts.——The Municipal Council of Sydney invite tenders for high tension underground cables.——The Municipal Council of Johannesburg invite tenders for the supply of high-tension cubicles.——The P.W. Dept., Wellington, N.Z., invite tenders for metering equipment for the Mangahao power scheme.——The P.W. Dept. at Wellington, N.Z., invite tenders for indoor and outdoor type apparatus for the sub-station at Penrose, Auckland, to be presented by December 11.——The P.W. Dept., Wellington, N.Z., invite tenders for the supply of transformers for the Waikato power scheme. Specifications, etc., at the D.O.T. (Room 52), 35, Old Queen Street, London, S.W.1.

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A POPULAR SCIENTIFIC WEEKLY JOURNAL
ELECTRICITY
A PRACTICAL TRADE JOURNAL

OCTOBER 19, 1923.

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PATENTS AND ELECTRICAL ENGINEERING.

The matter of Letters Patent for inventions is one of material importance to electrical engineers and of real practical interest. It is found that although very many inventions are made by electricians, few are conversant with even the elementary principles underlying the law.

At the present time about 30,000 patent applications are filed every year. These may mature into grants preventing others using what they validly claim for a term of 16 years. Of these applications some 70 to 80 per week deal with electrical matters covering such diverse subjects as electro-magnets, storage battery plates, terminals, electric flat irons, tuning apparatus for wireless telegraphy and telephony, electro-magnetic sound-producing devices, electrolytic systems for preventing the corrosion of metals, variable condensers, resistances and electric switches. The number of complete specifications accepted is only a fraction of the applications filed, the reasons underlying this being anticipation as shown by the Patent Office search, lack of further interest of the inventor, insufficiency of capital or inability to place the apparatus on the market.

Inventors often find it most difficult to ascertain whether what they have found is indeed an invention in the eyes of the law or a discovery. Patent Law is based on the Statute of Monopolies, which retains the right of the Crown to grant vadid patents for manufactures which are new within the Realm. It is therefore clear that unless a "manufacture" is the result of what it is sought to patent no valid patent can be secured.

It is one of the first duties of the Patent Office to ascertain whether a document presented to them deals with a manufacture. An electrical engineer may have worked out some elaborate improvement in dynamo design, and he may well regard it as an invention, this view being upheld by his colleagues. In all probability it would not be an invention as defined by the Patents Acts, because there would be no new manufacture, but merely, say, a scheme for regulating the sizes of parts or something of that nature. In some special cases it is true there may be a patentable new construction. That is quite a different matter.

The reported patent cases help materially in showing what the Courts regard as patentable inventions, for on these cases Patent Office practice is based and an understanding of them will often save time and expense to inventors, preventing them from seeking for patents for something which cannot be granted. Conversely, it may serve to show that some improvements, of which little may be thought at the time, may indeed form the basis of patentable inventions and be entitled to valid protection.

The well-known litigation relating to the gasfilled lamp dealt with a patent in which both theory and manufacture were combined. The invention related to the practical method of applying an atmosphere of gas to a tugsten filament contained in a glass bulb, and it was found for success that the filament had to be coiled into a spiral or else that it had to be made with a small surface in some other way, for instance, by employing a filament of large diameter.

According to the description contained in the specification the inventors found that the loss of energy by convection and conduction was substantially independent of the size of the filament, that is to say, as between a filament 10 mils in diameter and a filament 3 mils in diameter there is very little difference in the magnitude of the conduction and convection losses. On the other hand, the surface areas of the two filaments being in the ratio of 10 to 3, there will be radiated from the 10 mil filament three times as much light as from the 3 mil filament, because the light emission at a given temperature is proportional to the surface.

All these facts deal with discovery only, and a patent for them could not be validly secured.

The inventors, however, went further, and showed how this discovery could be applied and the claims of their patent were drawn to a construction of incandescent electric lamp. Those claims were ultimately upheld by the House of Lords, and the case may therefore be regarded as a good test case.

Many years ago Lord Lindley pointed out that an invention is not the same thing as a discovery. In one of his judgments he stated that "when Volta discovered the effect of an electric current from the battery on a frog's leg he made a great discovery, but no patentable invention. A man who discovers that a known machine can produce effects which no one knew could be produced by it before may make a great and useful discovery, but if he does no more his discovery is not a patentable invention. He has added nothing but knowledge to what previously existed. A patentee must do something more. He must make some addition not only to knowledge, but to previously known inventions, and must use his knowledge and ingenuity so as to produce either a new and useful thing or result or a new method of producing an old thing or result."

According to the Patent Office Rules no patentable manufacture is regarded as present where no material product of a substantial character is realised or affected by the alleged invention. Something of industrial application is the key to the basis of all valid grants and not matters of theory. It may well be said that among the printed specifications published by the Patent

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Office many are to be found dealing with only theoretical matters, for example, the testing of materials to ascertain their electrical magnetic properties. The answer to this is that they may have been accepted before the present patents laws and the practice thereunder were in force or, although accepted, they may not indeed be valid. Many cases tested in the Courts proved to be based on invalid patents, and it is no criterion of validity that the Patent Office have accepted a specification. The examiners are bound under the law to certain lines of investigation only, but in litigation proceedings and, indeed, even in opposition proceedings before the Comptroller of Patents, other matters may be brought forward which were not within the scope of the examiner's search and could not rightly have been cited by him even if he personally were aware of them.

These points relate rather to the novelty of an application than to the determination of whether the matter dealt with deals with a manner of manufacture or not, but the points are correlated, because the statute which requires an invention to deal with a manner of manufacture also specifies that it must be new within the Realm. These requirements being satisfied, a valid patent may be obtained for the sole right of making, using, exercising and vending the invention. Because of these terms which appear in the actual grant of the Letters Patent, it necessarily follows that what may validly be protected is only something which can fall within their scope. Matters which do not relate to manufacture, and therefore cannot be sold or vended, are excluded. On the other hand, a process is included, such as a particular process in connection with electro-deposition of metals, if the result be a new manufacture, and it is well settled by law that the vending of new products made by a patented process, although the products are not claimed, constitutes an infringement of the rights of the patentee.

C.A.V. AUTOMATIC BOAT-LIGHTING EQUIPMENT.

Although C.A.V. automobile lighting and starting sets are well known, it is not so widely appreciated that during the last 10 years the C.A.V. Co. have been installing lighting equipments in many of the best type of cabin cruisers and in large numbers of Admiralty boats of the Submarine Chaser and Fast Survey types. As a result they have now established what they style the "C.A.V. Marine Simple, Safe and Seaworthy Lighting, Starting and Ignition Systems," and their exhibit at the recent Shipping, Engineering and Machinery Exhibition attracted very considerable interest. It included dynamos, starters, combined dynamotors, automatic dynamo and light control boards, instruments, cut-outs, cabin lights, syrens, searchlights, signalling gear and navigation lamps, also a range of new batteries with threaded rubber insulation, coil and magneto ignition systems, etc. The automatic boat-lighting apparatus, with which we are now more particularly concerned, has been patented by T. Blair and Co, of King Street, West India Dock Road, and is made by C. A. Vandervell and Co., Ltd., of Acton Vale, W.3. It was designed because of the various recent shipping accidents, where ship's boats, having been launched, have been quickly lost sight of or run down, and consists of an electric light carried on pillars at each end of the boat operated by an automatic switch, the current being supplied from an accumulator capable of operating each light continuously for 24 hours, or longer if desired. The pillars are secured at each end of the boat inside the gunwale and hinged so as to stow flat beneath the level of the capping, thus allowing the boat to be covered in the ordinary way. They are easily thrown into the vertical, and retained in this position by means of a spring plunger. The lamps are fitted to the end of the pillar and protected by a stout metal guard which, with the glass dome, forms a watertight joint, thus preventing the lamp terminals from being short-circuited by sea water.

Tumbler switches are fitted to the pillars. The automatic switch consists of a stout copper tube terminating in a switch box, and carrying a float, which, when operated by the pressure of water places the switch to "on."

This copper tube can be built into the boat, or secured alongside the stem and stern posts outside the boat. The battery is made in various sizes, and retains its charge for six months. A switch is fitted. Three-core cables, heavily insulated and protected by rubber, connect the automatic switch, battery, and lamps.

On the boat being called away for service:—

As soon as one end is uncovered both lights can be switched on by the tumbler switch fitted to the pillar, the light thus obtained assisting in enabling the boat's crew to get the boat clear away, falls and life-lines clear, and the boat swung out on its davits.

In the case of a life-boat, "griped to" at the davits, the pillars could be at once thrown into the vertical position, and the lights switched on. This would give sufficient light for all necessary purposes and avoid the use of a yard-arm group.

Should the ship's lighting circuit fail, sufficient light is available to enable the boats to be manned at the rails with their complement of passengers.

If, through any cause the boat is placed in the water, either by over-running its falls or floating off a sinking ship, the automatic switch would at once operate the lights, thus indicating the position of the boat to swimmers in the water. Further, the probability of a boat being picked up is increased by the fact that the lights would be sighted by any ship passing, and if necessary signals could be exchanged between the boat and ship by use of the switches.

In addition to the above, in harbour when boats are compelled to carry hand-lamps, and show when passing other boats, the lights being already in place, only need switching on.

THE ALL-BRITISH WIRELESS EXHIBITION.

A forthcoming attraction, appealing particularly to wireless enthusiasts, is the All-British Wireless Exhibition and Convention, to be held at the White City, Shepherd's Bush, W., from November 8 to 21. This Wireless Exhibition, the largest ever held in the world, is being organised in conjunction with the National Association of Radio Manufacturers, an organisation which can already point to a splendid record of achievement in the best interests of popular British wireless. The active participation of this powerful Association will ensure presentation on an adequate scale of all that is most up-to-date in wireless progress.

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Apart from the actual exhibits, comprising almost every conceivable form of wireless apparatus, there will be a series of lectures and demonstrations—the latter by special arrangement with the British Broadcasting Co., Ltd. Full advantage is being taken of the ideal facilities of the White City to provide for the comfort and convenience of visitors on an elaborate scale. The Exhibition Organisers are Bertram Day and Co., Ltd., 9 and 10, Charing Cross, London, S.W.1, who have already conducted successful wireless exhibitions both in London and Manchester.

THE MANUFACTURE OF STEAM.*

By W. E. Highfield, M.I.E.E.

(*Concluded from page* 552.)

Regarding other instruments, these may be CO_2 meters, temperature indicators, flow meters, etc., etc. All these are important, but it is often sufficient to arrange these instruments so that they are not necessarily in service continuously, but only used when the coal and water measurements show that one particular boiler is not being used efficiently. Particularly is this the case with a small station where the cost of such instruments on every boiler is prohibitive.

I had not intended to deal with any item in detail, but it is perhaps necessary to mention the CO_2 meters rather more particularly as their function is not always clearly understood.

The CO_2 meter is a means of measuring what may be termed a raw material, though as this material costs nothing it is not usually termed so. It measures the air required for the proper combustion of the fuel. The direct measurement of the air would be far too costly a method to adopt, and the CO_2 meter is the simplest method evolved for doing this indirectly.

The CO_2 meter is a means of ensuring as far as possible that the quantity of air passing into the furnace shall be properly proportioned to the quantity of fuel being burnt. Any air in excess of the minimum required is a great source of waste, as it cools the fire and the heating surface, and, being discharged up the chimney at a high temperature, it carries away a lot of useful heat. On the other hand, it is very important that the air supply shall be adequate, for if it is deficient some of the carbon in the fuel is burnt to CO instead of CO_2. A pound of carbon burnt to CO only evolves 4,400 B.Th.U., whereas if completely burnt 14,500 B.Th.U. would be produced, so that the loss by incomplete combustion is very serious indeed.

As air contains approximately 21 per cent. of oxygen by volume and 79 per cent of nitrogen, and as oxygen used for burning carbon produces the same volume of CO_2, it follows that if the whole of the oxygen in the air supplied to a furnace were used in burning pure carbon, the flue gases would contain 21 per cent. by volume of CO_2. But this percentage is quite impossible to obtain in practice. The combustible part of ordinary coal contains a considerable percentage of hydrogen which forms water-vapour when burnt, and therefore contributes nothing to the CO_2. In oil-fuel and natural or artificial gas, the hydrogen content is a more important constituent even than in coal, and the percentage of CO_2 formed with such fuels is therefore theoretically much less than with carbon. When burning solid fuel it is always found in practice that unless from 50 per cent. to 100 per cent. more air is supplied than is theoretically needed to burn the combustible constituents, some of the carbon will only be burnt to CO, with a resulting loss in efficiency. Hence excess of air has always to be supplied, and in practice more than 14 per cent. CO_2 is never striven for. It is generally taken that, with no excess air, the perfect combustion of ordinary bituminous coal would give about 19.2 per cent. of CO_2 in the flue gases, the figure depending principally upon the hydrogen content. It is also assumed that about 12 lb. of air would theoretically be required to burn a pound of such coal. Hence, if in actual practice the CO_2 amounts to 14 per cent., it follows that $\frac{12 \times 19.2}{14}$, or about 16.5 lb. of air, are being used per lb. of coal. It is thus evident that the CO_2 meter may be regarded indirectly as an air-meter, provided that the composition of the fuel is known.

While it is very important to maintain the CO_2 percentage as high as possible, so long as CO is not present, and for this purpose a CO_2 indicator or recorder is indispensable, I wish to utter a warning against the idea that all must be well in the boiler-room if the CO_2 figures are satisfactory. The engineer does not want CO_2, but steam, and the CO_2 record by itself conveys no information as to whether this steam is being raised with the minimum amount of coal. If the boiler is dirty, inside or out, all the CO_2 in the world will not help matters. A high CO_2 figure combined with a low stack temperature is certainly significant of efficiency of operation, but the real test, as I have already said, is the amount of steam made in comparison with the quantity of coal burnt. The CO_2 recorder, like the flue-gas pyrometer, is a purely secondary and subsidiary instrument, whose main function is to assist in locating the cause of inefficiency.

Summarising my remarks at this point, I have endeavoured to show the position the boiler-house holds with regard to the economical running of a central station, the importance of careful personal management and the essential factors on which economical running depends.

Many items of importance and interest have been omitted so that what may be termed the L.C.M. of boiler-house management should not be obscured.

Before concluding my address I will touch on a few points that show the trend of modern boiler-house practice.

I will first deal with the general tendency towards an increase in pressure which is very marked at present.

The theoretical advantage to be gained by an increase in pressure may be put quite briefly.

The amount of work a pound of steam will do depends upon the amount of heat the steam contains, and comparatively little extra heat is obtained by increasing the pressure.

Considering saturated steam only, if the pressure is 100 lb. absolute, the percentage of the total heat put into the steam, which is available for work if the steam can be expanded down to a 28 in. vacuum, is 26.2 per cent. With steam at 250 lb. initial pressure, under similar conditions, the figure is 31.0 per cent., while with steam at 500 lb. initial pressure and the same conditions, the figure is 34.3 per cent. The possible gain is not, therefore, very great.

* Presidential address before the N.A.S.E., September, 1923.

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If the steam is assumed to be initially superheated to 700 deg. Fah., which is about as high a temperature as can be safely used, the corresponding figures are 28.5 per cent., 32.6 per cent., and 35.7 per cent.

One of the reasons for the tendency to increase steam pressures is to reduce the size of pipes necessary for carrying the enormous amount of steam which has to be transmitted in modern large power stations. There are, for example, turbo-generators running which consume as much as 150 tons of steam per hour, and the conveyance of such large quantities is no small matter.

On the other hand, as showing what can be done with comparatively low-pressure steam, I may mention the results obtained at the Radcliff station of the Lancashire Electric Power Company. There, in spite of the fact that the working pressure is only 160 lb. per square inch, the station results for six months gave a coal consumption of only 1.866 lb. per kilowatt-hour delivered to the feeders. This example is sufficient to show what results careful management of the boiler-house will give.

Before deciding on an increase in pressure the increased capital cost must be weighed against the probable saving. Naturally, high-pressure plant costs more than low-pressure plant. Not only do the boilers cost more, but the auxiliaries, the pipework and other items increase in a regular proportion.

Without going into details the general tendency appears to be for very large stations to be laid down for pressures between 350 and 500 lb. For medium-sized stations there appears no reason for going beyond 350 lb. The cost of plant for 350 lb. is very little different to plant for 250 lb., whereas beyond 350 lb. the cost increases considerably.

As progress in one branch reacts on other portions of the equipment, so the increase in pressure has effected other items besides the boilers and pipework.

In the past, for plants up to 250 lb. pressure or thereabouts, the economiser has been a standard part of the boiler-house equipment. But there is certainly some reluctance to employ cast-iron economisers for pressures of 350 lb. and upwards. Steel tube economisers have not always been successful, and to meet the difficulty there has been a tendency to adopt pre-heaters. Instead of taking the exhaust gases from the boilers and passing them through an economiser for heating the feed water, the gases are taken through the air heater and utilised for heating the forced draught to the grates. The air heater, equally with the economiser, will reduce the temperature of the exhaust gases to the chimney stack so that the losses in this respect can be kept at a minimum. The result of leading hot air to the boiler grates improves the combustion, and it may, and probably will, result in the alterations to the brick arch necessary with chain-grate stokers, the renewals of which are one of the principal items in the maintenance cost of the boiler-house.

The air heater is certain to be one of the points on which attention will be centred in the future, and no doubt it will also be the centre of controversy. Notable advances have also been made with pulverised fuel plant, and especially has this been so in America.

Pulverised fuel has two great advantages. It allows the fuel to be more economically burnt, and it allows lower grade fuel to be used. The first point I wish to avoid, as it leads to detail with which my address is not concerned. But the second point is one of general importance to all. There are vast quantities of low-grade fuel which hitherto have had to be dumped, but which will now be available. Further, it increases the value of our coal mines, for the "duff," or waste, will have a commercial value, and as the use of electricity extends, so will the value of the duff increase, since it will have a larger market. The price will always be limited, because it is only the waste of a higher grade, but it is not safe to assume that the price will be the almost nominal sum for which it can be purchased to-day.

I do not wish to tire you, but I think I have said enough in the latter part of my address to show you that progress was never more active than it is to-day in the field of steam-producing plant, nor has the future been brighter for the electric supply industry.

SMALL-POWER WIRELESS TELEPHONE TRANSMITTER-RECEIVERS.

A wireless telephone set, called the "Popular," for communication over distances of 10 or 20 miles, has recently been designed by Marconi's Wireless Telegraph Co., Ltd. (Marconi House, Strand, W.C.2). It is made for both simplex and duplex working, and is particularly adapted for use where no other means of communication exists, or where existing land-lines are unreliable. For example, it could be used to advantage between a factory and distant office or between a ship in port and the shipping office, etc. For simplex working, i.e., speaking only one way at a time, one aerial at each station is required, and speech in either direction is carried on the same wave-length, a switch being provided at each end to stop the transmitter from radiating when receiving. For duplex working, i.e., speaking in either direction at the same time (as on an ordinary wire telephone installation), a double aerial at each station is necessary and communication effected one way on one wave-length and the other way on a different wave-length. In the "Popular" set the wave-lengths are 190 and 260 metres, and with the small power radiated interference of the transmitter with the receiver at the same station is eliminated without the use of "balancing circuits." For duplex working each aerial at each station must have an independent earthplate, separated by at least 6 ft., and for satisfactory working the horizontal portion of the two aerials should not be more than 20 deg. out of the straight line and the down leads not less than 20 ft. apart. It is best to have the two aerials fixed one behind the other (and insulated from one another) using only two masts, about 200 ft. apart for single wire and 120 ft. for twin wire. Full-strength speech is obtainable over at least 10 miles with the aerials 30 ft. high and 20 miles if they are 70 ft. high. Needless to say, the sets are strongly and conveniently designed for commercial use.

I.E.E. Meeting Hour.—The recent postcard vote taken among the members having addresses in the London district shows that the majority of those who voted were in favour of 6 p.m. for the ordinary meetings of the Institution, and it has accordingly been decided to continue to meet at 6 p.m. (Light refreshments at 5.30 p.m.)

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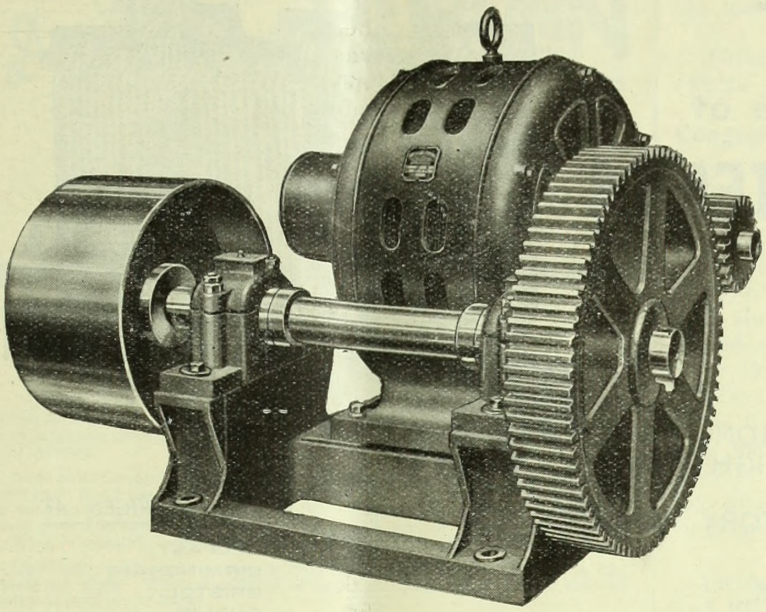


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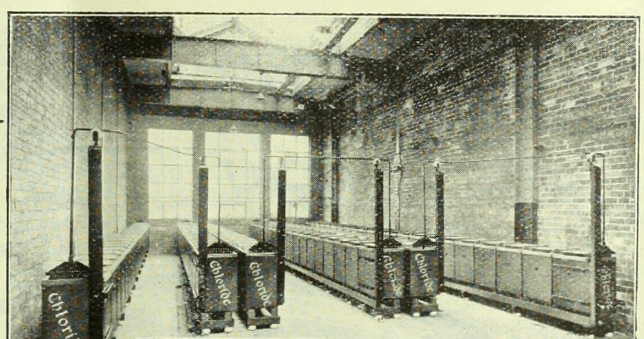
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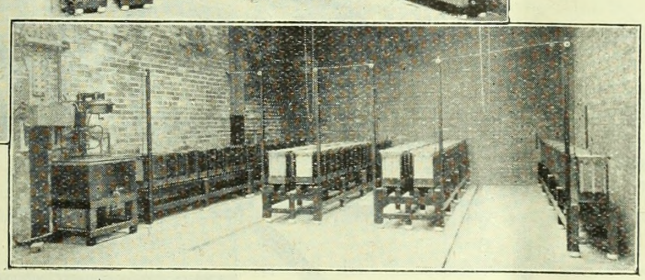
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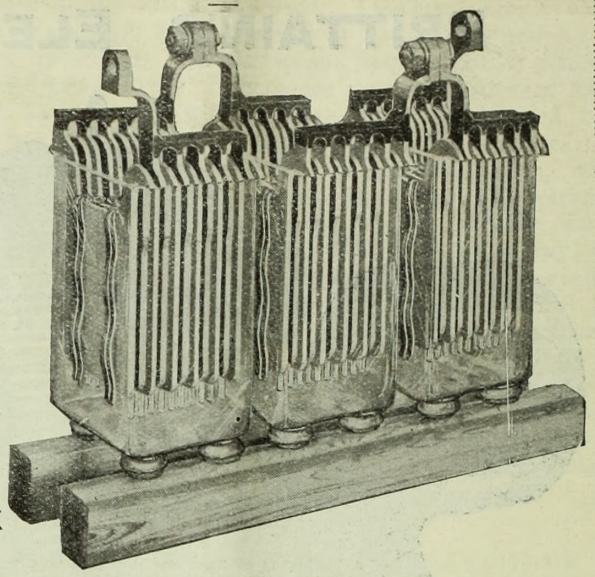
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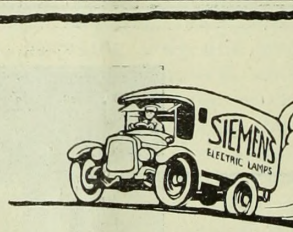
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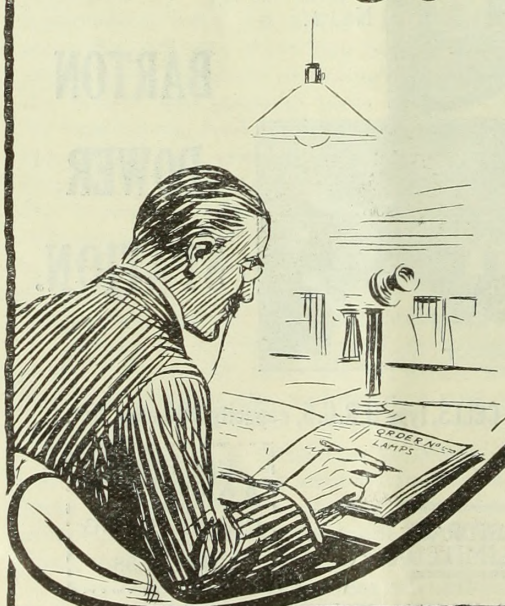
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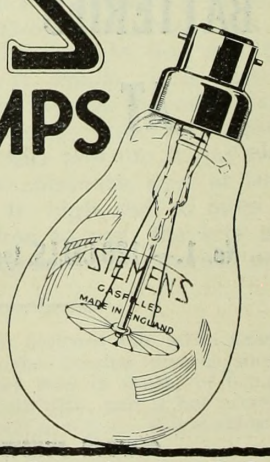
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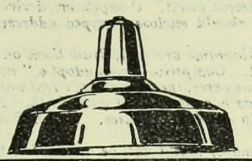
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New advertisements for the displayed columns and alterations to existing ones must reach the publishing office not later than first post Tuesday morning, in order to be in time for the issue of the following Friday. This is important. Rate quoted on application. Subscription: 13s. a year, 6s. 6d. half-year, 3s. 3d. a quarter in advance, postage prepaid in the United Kingdom and abroad.

Questions to which an answer is required must be accompanied by a 1½d. stamp for reply. When considered of sufficient interest, the answer will probably appear in the paper.

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Current Topics.

The Breakdown Season.

The season of recurrent electricity breakdowns, to which I referred a week or so back, has apparently set in with a vengeance. Aberdeen has experienced the worst inconvenience so far, with a complete failure of the city's electricity supply for the space of thirty-five minutes, the trouble being ultimately traced to a mouse, which, gaining access to a high-tension switch chamber at the works in Dee Village, found its way into the air-gap between two 6,000-volt terminals, and yielding up its life, caused a short circuit, which threw the entire supply into confusion, and led to a temporary cessation of the distribution of upwards of 11,000 h.p. Fortunately, the mishap occurred during daylight, and only affected the tramways, lifts, power installations, etc., but sufficient capital has been made out of the incident by the Press to cause a good deal of harm to the reputation of the supply industry.

Failure of the electric light in Chiswick recently on a Saturday evening threw several shops and a cinema into darkness for the space of half an hour. Here also, the various premises affected were full of customers and patrons, and business was in full swing. The mishap is stated to have been due to the blowing of a fuse in one of the distributing boxes. Turning to tramways, failure of the current supply at the power station caused a temporary stoppage of the L.C.C. trams on various routes in London last week, whilst in Liverpool, during a recent visit to the city, I was personally held up by a succession of minor breakdowns in the centre of the city during the busiest hour when the business population were vainly endeavouring to get home to the suburbs. I counted no less than 46 cars held up in one long procession, within quite a short length of single-track route, and before we struck a lucky patch on the car I had boarded, we were held up no less than four times, apparently by the automatic action of a section circuit breaker

Congratulations.

Although the city of Aberdeen has just suffered the effects of a temporary electricity breakdown, it has been more fortunate in the matter of broadcasting, for it now possesses a broadcasting station of its own, which was opened last week with inaugural speeches by Sir William Noble, late Engineer-in-Chief of the Post Office, the Lord Provost, and the Marquess of Aberdeen and Temair, P.C., G.C.M.G., G.C.V.O., all of which were relayed and simultaneously broadcasted from all the British Broadcasting Stations with great clearness. There were also given appropriate selections by the pipe band of the Gordon Highlanders, a species of music which lends itself admirably to loud-speaker reproduction. I was listening-in at Liverpool, and the speeches came through most faithfully, together with the accompanying applause, and certain "asides" at the transmitting end, which were not intended for publication.

Incidentally, the effect was marred in the Manchester and Blackburn districts, I believe, by the ill-considered action of certain amateurs, who were superimposing their wholly uninteresting and objectionable conversation on the ether at approximately the same wave-length and concurrently with the speech of the Marquess. From reports issued from the Manchester station of the B.B.C., it would appear that this station, and its immediate listeners-in, is experiencing a good deal of trouble with oscillating fiends and amateurs given to practical joking of an essentially purposeless and fatuous character. I am advised that steps are being taken to locate the sources of disturbance, and that legal proceedings will follow under the Wireless Telegraphy Act. I only hope the efforts to scotch these gentry will be speedily successful; such ether-hogs are a curse to every other interested member of the commmunity, and in olden days would have been hanged to the highest available aerial when detected. I am not sure that they do not deserve a similar fate in these more humanitarian times. Anyway, I hope Uncle Victor and his merry men have a Carpentier run for their money when the identities of the offenders are disclosed. Meanwhile, my sympathies are with the Manchester station.

Apathy or Influence?

I wonder whether some municipal electricity supply undertakings, even in our largest provincial cities, really do intend to encourage the domestic load. A man I know in a northern city has waited weary years for the cables to be laid along his street, and I heard from him the other day to the effect that there was a gleam of hope. Corporation workmen had appeared at last, with big drums of cable, and were actually trenching under the side-walk opposite his house. He had not been canvassed, nor had he received any postal intimation of the Corporation's intentions, but rumour had it that very favourable terms were being offered to tempt new consumers to join up and take a lighting, heating, and cooking supply.

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I heard from him again, only yesterday, to the effect that he had sadly witnessed the route of the main being diverted from the opposite side of the street to his own side, some fifty yards lower down, and that there was no apparent intention to furnish a service to the block of houses which included his particular residence. He had accordingly written to the Corporation Electricity Department a courteous letter of inquiry as to their intentions and the terms on which he could be connected. That was a week ago, and up to the time of his writing to me he had not even received an acknowledgment of his letter, nor had any representative been to see him. Now I submit that if this perfectly true incident is an example of the manner in which municipal electricity committees are handling the business of domestic electricity supply, it is high time the powers they now possess were taken out of their hands and vested in private enterprise. It is significant that gas interests and a private gas company bulk large in the particular city referred to.

Broadcasting Electricity.

Under the auspices of the Federation of British Industries, Mr. Hugo Hirst, of the General Electric Company, recently broadcasted from the London Station of the B.B.C. a ten minutes' discourse on the electrical engineering industry. It was physically impossible within the time limit set to deal adequately with the wide field covered by the title of Mr. Hirst's address; but he nevertheless spoke in his usual interesting vein, looking well ahead into the future and its possibilities of unforseen development in the various branches of the industry. Mr. Hirst is essentially an optimist, and is to be congratulated upon the interest evinced by his speech, which must have been heard by thousands of listeners-in, and should aid the general cause for the advancement of the industry.

There is a tremendous amount of leeway to make up in the education of the public mind on the subject of domestic electricity, and in this connection, occasional broadcasting talks could do excellent service. If the E.D.A. could organise a series of popular addresses on the subject of electric lighting, heating, cooking, and labour-saving generally, and arrange for them to be delivered preferably in the afternoon programmes when housewives have more leisure than at other periods of the day, they would be calculated to win over many converts. As quite a recent convert or victim of the broadcasting fever I have already listened to several lecturettes on subjects of which I was comparatively ignorant, and have found them most interesting. Per contra, there must be many hundreds of potential consumers who would be interested in such addresses as I have suggested above.

Elektron.

WHAT IS IT?

Joe: "Is it a lap or a wave winding?"
Jack: "I don't know."
Joe: "How shall we find out?"
Jack: "I don't know."
Apprentice (standing by): "Get 'Armature Winding,' by Sylvester, it will tell you how to find out quite easily."

Questions and Answers by Practical Men.

RULES.

Questions: *We invite our readers to send us questions, preferably on technical problems that have arisen in actual practice. Questions which we consider of sufficient interest to our readers will either be replied to under "Answers to Correspondents" or replies will be invited from our readers. One shilling will be paid for the question which we select for competitive replies in this column.*

Answers: *A fee of 10s. will be paid for the answer which we consider shows the greatest merit, and 5s. for the one we select as second best. In judging the replies, importance will be attached to clearness and conciseness, as well as accuracy. The Editor reserves the right to make no award, or to accept only one reply, if, in his opinion, the answers received do not possess sufficient merit. Competitors desiring the return of their manuscripts, if unaccepted, should enclose stamped addressed envelope.*

Write on one side of the paper only, and if diagrams are sent, draw them on a separate sheet of paper attached to the manuscript. Competitors may adopt a "nom de plume," but, both in the case of questions and answers, the competitor's real name and address must be sent with the manuscript as a guarantee of good faith. No correspondence will be entered into with regard to successful replies. The Editor's decision is final.

Commencing with Question No. 101, a Diploma of Merit will be awarded to the six competitors who win the first or second prize the most times during the next twelve months.

The words "Questions and Answers" or "Q" and "A" should be placed at the top left-hand corner of all letters intended for this column.

Question No. 169.

I wish to make a resistance to reduce a pressure of 200 volts to 25 volts. I would appreciate details of size of wire, method of mounting coils, etc. The maximum current I wish to take from it is 15 amperes.—J. R. Woodhatch.

Question No. 170.

I desire to make a testing board suitable for testing motors, elements, etc. The supply is 200 volts. Can any reader tell me what instruments and apparatus I shall require, and method of mounting?—J. R. Woodhatch.

(*Replies to Questions Nos. 169 and 170 must be received not later than October 27, 1923.*)

Answers to Questions.

Question No. 164.

I have an electric iron, but it has gone wrong. I have opened it out, and I find that the element is what appears to be aluminium paint on mica. I also notice that the circuit through this paint is interrupted. Since I cannot purchase a spare element, is there any means of repairing the defective element? If not, how can I convert the iron to use another element?—"Launder."

Replies to Question No. 164.

The first prize (10s.) has been awarded to "L. R." for the following reply:—

STRIP HEATERS.

Strip heaters of the kind indicated comprise a very thin film of metal, painted or otherwise, affixed in a suitable medium to a mica base. They are of high resistance because of the thinness of the film, and for that reason in operation reach a comparatively high temperature. Under these circumstances, in due course disintegration or cracking occurs, and this often takes the form of a break across the width of the film.

Such heaters are used in many forms of electric apparatus—for instance, electric irons, electric kettles and electric radiators. If a fault has occurred, the best course to pursue is to replace the element, and that may often be done by obtaining a spare element from some other apparatus, such as a radiator, when a new one cannot be secured.

An alternative scheme which works for a time is to paint over the cracked part or discontinuity in the metal by means of ordinary aluminium paint thinly

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applied. This cannot successfully be done if several cracks have appeared longitudinally as well as across the metal. In that case, if the element cannot be renewed, the heater must be replaced either by other elemnts or some form of resistance.

It may be noted that many patents have been taken out for the construction of elements of this character, and working on their lines one may in any particular case be able to manufacture suitable replacements.

According to one of these methods a thin coating of platinum or gold is first formed on the base to which it is to be applied, either by painting or flowing platinum solution or gold solution thereon, and heatng it to reduce the liquid to the metallic state.

An alternative scheme consists in pouring on a tin chloride solution, washing, applying a solution containing gold or platinum, caustic soda and glycerine, and keeping the article warm until the film has deposited. After cooling, a solution of platinum chloride is applied, and the article heated to render the coating metallic. It is then coated electrolytically with platinum.

According to another method, the metallic coating may be produced by the application of painter's gold or by precipitation from solutions as in mirror silvering, the metallic layer being strengthened by electrolytic deposits.

About twenty years ago, Arnold, of Germany, patented a commutator arrangement in this country in which resistances connected between the segments were formed of conducting films painted upon insulating material by solutions containing finely divided metal.

If no replacement of the above character can be made, a metallic wire or strip heater may possibly be substituted, but this depends on the space available and the particular resistance element chosen. As a guide, the following figures may be of assistance with reference to a well-known material:—

	S.W.G.	Approximate resistance per 1,000 yards		
		at 200°C.	400°C.	600°C.
Nickel Chrome	16	452 ohms.	495 ohms.	538 ohms.
" "	32	15,880 "	17,360 "	18,900 "

The former sized wire at the temperatures mentioned would carry 7.1, 12 and 18 amperes respectively, the figures for the latter sized wire being 0.55, 0.80 and 1.2.

For tapes made of the same material, a tape of width 1-16 inch, and thickness 0.003, at 200 deg. C. carries 3.1 amperes and has a resistance of 7,596 ohms per 1,000 yards. At 600 deg. C. it carries 7.1 amperes, and has a resistance of 8,780 ohms per 1,000 yards.

"L. R."

The second prize (5s.) has been awarded to "Unit" for the following reply:—

The heating element in "Launder's" iron is evidently one of the old "paint" elements which were manufactured in the early days of electric heating in this country by a firm which has since passed out of existence.

This type of element consists of finely divided particles of precious metals deposited on a thin sheet of mica. The formula for the composition of metals employed would be extremely difficult to obtain, and as this would doubtless vary with the resistance of the elements, it will be seen that it is practically impossible to repair the element in its present form.

Probably the best way out of the difficulty is to have a modern type element made to the exact dimensions and loading of the old element. One of the many firms who specialise in electric heating would doubtless undertake this work, or, provided the materials required are available, "Launder" could himself make the element, in which case the following may be of some assistance.

It will first be necessary to cut two pieces of mica to the same size and shape of the old element, and then two pieces must be cut on which to wind the resistance wire. These winding pieces must be arranged so that when placed on one of the pieces of cover mica there shall be a gap between them at the centre and that the outside edges do not quite reach the edge of the cover mica.

We now come to the winding, which will probably present the most difficulty. First the resistance of the winding must be calculated. The voltage and either the amperage or wattage will be marked on the iron, and from these particulars the resistance may be calculated by Ohm's law. It must be remembered here that the resistance of the winding must be less than this calculated value in order to allow for the increase in resistance as the wire becomes hot. The allowance to be made will depend to some extent on the particular make of wire used, but I think that 10 per cent. is a fair average value to adopt. With regard to the wire to be used, this will be a high resistance wire, of which there are several types on the market under various trade names, "Chronic" and "Nichrome" being two of the best known.

Unless he is familiar with the use of this wire, "Launder" may experience some difficulty in deciding upon what gauge of wire will be most suitable. This will be governed by the amperage and resistance of the element, and the resistance per unit length (resistance per foot, say) of the wire must be known. The wire used must be heavy enough to carry the stated current and of a length which can be comfortably accommodated on the winding mica. Having decided upon the wire, it must now be wound on to the winding mica, care being taken to keep the turns equally spaced.

The two separate halves of the complete winding must be connected together at the top end and two metal connecting strips attached to the wire at the bottom end of the element. The two pieces of insulating or cover mica must now be placed one each side of the winding, the two connecting strips being brought out through the top piece of mica. The winding is thus completely insulated, and the complete element may be fitted to the iron.

In conclusion, I would repeat that unless "Launder" has special facilities for this work he will be well advised to put it into the hands of a reputable British firm.

"UNIT."

[NOTE:—If "Unit" will forward his address to this office the prize money will be sent to him.—EDITOR.]

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SOME FEATURES OF C.P.T. DIRECT CURRENT ARC WELDING PLANT.

Where a steadying resistance is used in conjunction with a welding generator to choke down the rush of current when the arc is struck, the overall efficiency must of necessity be low, as even under normal working conditions most of the energy from the generator is wasted in the resistance. For example, where the normal output of the generator is 150 amps. at 100 volts, as the voltage across the arc is about 25 volts, only some 3.75 kw. are doing useful work, whereas 15 kw. are generated and have to be paid for. To do away with this waste generators have been designed to give a drooping characteristic, i.e., to respond to the voltage changes necessary to compensate for variations in the length of the arc resulting from any unsteadiness of the operator's hand and momentary short-circuits between the work and the electrode from drops of molten metal. Unless the voltage follows these variations practically instantaneously the arc is liable to go out, and bad work is the result. The generator designed by the Consolidated Pneumatic Tool Co., Ltd. (Egyptian House, Piccadilly, W.1), does this, the time lag between the current variation and the instant it responds to it being less than 1-10th sec. Further, as the short-circuit current is not greater than 25 per cent. to 30 per cent. above the normal welding current, there is a corresponding reduction of sudden and heavy stresses on the machines.

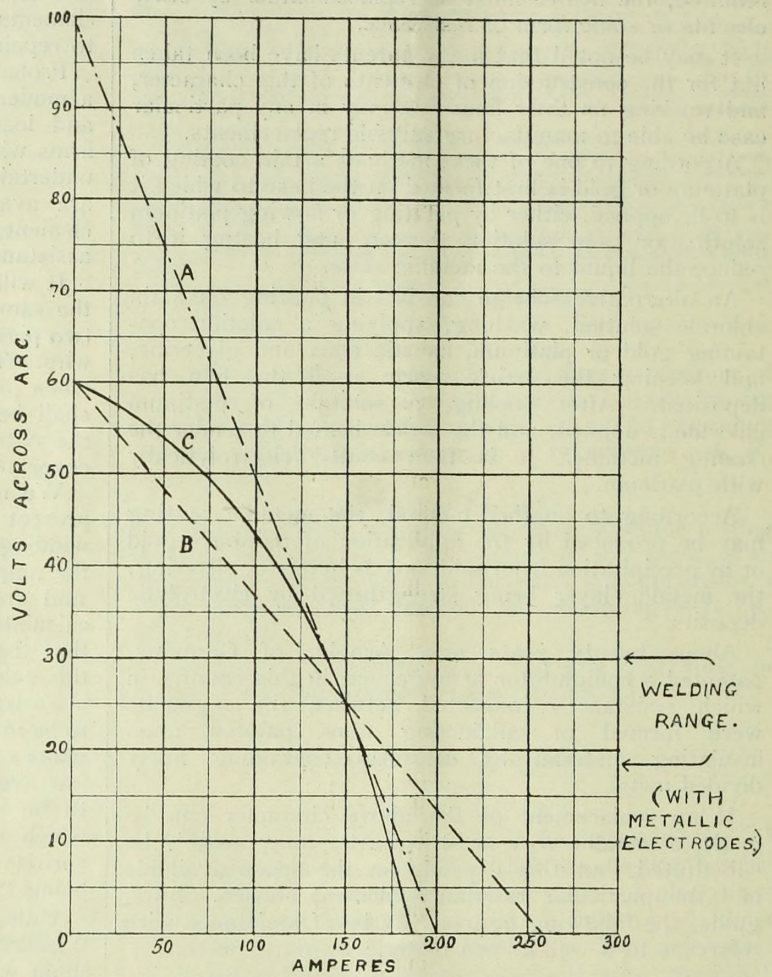
The differences in the welding systems just referred to are brought out clearly in Fig 1. With 100-volt supply and resistance control (curve A) there are two advantages, but they are paid for very dearly in wasted energy. First, a steep curve, which means that a slight current variation (on account of variation in the length of the arc) causes a large variation in voltage. This gives an easy arc, because immediately it tends to break the voltage rises rapidly to maintain it. The second is that the load is limited when the electrode touches the work and causes a short-circuit, because the arc only represents about 25 per cent. of the total load on the dynamo.

Sixty volts is quite sufficient to strike the arc, but the stress on the generator is much greater since the load increases 75 per cent. on short-circuit. This is shown by the point on curve B where it meets the base line. Zero volts at the arc means, on this diagram, that the electrode touches the work. It should be noted that a much larger current variation is needed in this case to obtain a similar voltage variation than is necessary with curve A.

With the C.P.T. dynamo no series resistance is used, as the required curve C is obtained by the special windings and construction. This gives 60 volts for striking the arc, and a stable arc over the working range without the excessive rise of current on short-circuit which takes place with other systems. It should also be noted that *the load on the dynamo is much less on short-circuit than when welding is in progress* since the voltage at the dynamo terminals drops away to a very low value, only sufficient to keep the short-circuit current flowing through the resistance of the armature and cables, usually about 4 or 5 volts.

For tramway and shipyard work, etc., where portability is a vital factor, the C.P.T. Co. have designed an exceptionally light motor generator set embodying the principles above dealt with. The fields of both machines are laminated and mounted in a light cast-iron case with only two end shields, fitted with ball

VOLT-AMPERE CHARACTERISTIC CURVES OF ARC WELDING SYSTEMS.



CURVE.	~ SYSTEM ~	POWER TO BE SUPPLIED.	CURRENT DROP TO OBTAIN 10% VOLTAGE INCREASE ON ARC.
A.	100 VOLTS. SERIES RESISTANCE.	15 K.W.	4·0 %
B.	60 D°. D°	9 K.W.	7·7 %
C.	C.P.T. WELDING DYNAMO	3·75 K.W.	3·75 %

Fig. 1.

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bearings. The weight is 590 lb. and the output 50/150 amps. (200 amps. intermittently) at 20/25 volts, the speed being 1,600 r.p.m.

In Fig. 2 is shown a unique portable welding plant, driven by a petrol-paraffin engine, combined with a compressed air plant which operates pneumatic tools (carried in the set) for preparing and finishing the work, etc.

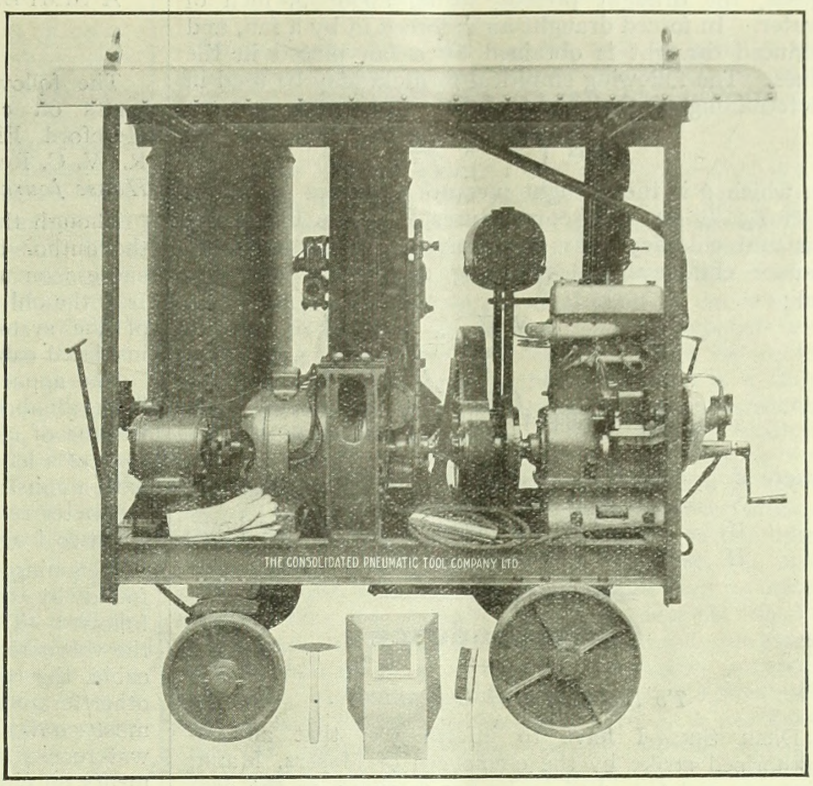


Fig. 2.—C.P.T. Direct Current Arc Welding Plant.

FUELS AND COMBUSTION.

The definition of coal would require a legal expert's knowledge as to whether it is or is not a mineral substance, and legal battles have been fought over the issue. It is generally allowed to be formed by the slow decomposition of ferns and mosses accompanied by enormous pressure of superincumbent geological strata and requiring a long time, geologically speaking, before it takes the form of coal as we know it to-day.

Coals are classified according to their richness in carbon and hydrogen, the other materials present being oxygen, nitrogen, sulphur and ash. An average sample of *Welsh* coal yielded the following analysis :—Carbon 87.8, hydrogen 4.3, oxygen 4.3, nitrogen 0.5, sulphur 0.7, and ash 3.5 per cent.

Scottish coal is not so rich in carbon, and contains more oxygen and ash. In evaporative power in pounds of water and in calorific value the former stands very high.

In order of richness in carbon, the following are the chief varieties, viz. :—

Anthracite.—This burns without smoke, giving intense heat. It is hard and lustrous in appearance, and is much used with gas producers, as it easily yields carbon-monoxide. It is almost wholly carbon, as much as 90 per cent. being free, the remainder being in the form of hydrocarbons.

Bituminous coal, caking and non-caking.—These are roughly divided into lump, nut and slack, depending on their sizes. They contain a large proportion of easily-gasified hydrocarbons, but have less free carbon than anthracite.

Cannel coal is a long-flaming variety, valuable for making coal-gas, as it contains a large proportion of ethylene and enriching gas made from other gas coals. The volatile hydrocarbons are as much as 60 per cent. of its weight.

Brown coal, or lignite, is the newest, and therefore the poorest, form of coal. Only about half its weight is free carbon, with little volatile hydrocarbons, while it leaves a large amount of ash on combustion.

Coke is especially useful in making power-gas. An average sample consists of carbon 90 per cent., sulphur 1 per cent., ash 8 per cent., with small amounts of oxygen and hydrogen.

Petroleum.—The United States, Mexico, Burma and Persia furnish the chief supplies, though Russia and Rumania have large oil-fields. This fuel is rich in hydrocarbons, carbon and hydrogen forming 94 per cent. of its weight.

Calorific values.—Taking the first four fuels in the order given, we find that Welsh, Scottish, Anthracite, Bituminous, Cannel, Lignite have average values of 15,000, 14,000, 14,000, and 14,000 British thermal units per pound, while petroleum is about 19,000 British thermal units for the same weight.

The *evaporative power* in pounds of water from and at 212° F. are about 15 for coal and 20 for petroleum. These values in B.T.U. per pound can be found theoretically from the expression, $14{,}600\,C + 53{,}300\,(H - \frac{O}{8}) + 4{,}000\,S$, where C, H, O and S represent the percentage of carbon, hydrogen, oxygen and sulphur present in the fuel.

Air required for combustion.—Theoretically, the weight of air per pound of coal is given thus :—

$11.6\,C + 34.8\,(H - \frac{O}{8}) + 4.35\,S$, where the letters have the meaning and values given above, but in actual practice the weight of air supplied is much higher. When the air supply is inadequate or the temperature is not high enough, there is much soot present with the furnace gases ; and, again, when the air is excessive, the inert nitrogen present acts as a diluent and lowers the furnace temperature. Fuels rich in volatile hydrocarbons require much care in the regulation of the air-supply and the temperature. This is attained by natural, forced or induced draught. In the first we have a chimney, and it depends for its action on the difference in densities of the air and lighter furnace

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gases, the draught pressure being about .5 inch of water. In forced draught air is forced in by a fan, and induced draught is obtained by a fan placed in the flues. The following empirical formula may be used in determining H, the height of the chimney, viz. :—

$$p = H\left(\frac{7.6}{T_1} - \frac{7.9}{T_2}\right)$$

in which p is the draught pressure in inches of water, and T_1, T_2 are the temperatures (absolute F°) of the air and chimney gases respectiveiy. For round and square chimneys the following expressions are useful :—

$$d = 3.32\sqrt{\frac{W}{\sqrt{H}}} + 4$$

$$S = 2.94\sqrt{\frac{W}{\sqrt{H}}} + 4$$

where d = internal diameter, in inches ;
S = side of square chimney ;
W = weight of coal burnt, in pounds per hour,
H = height of chimney, in feet.

Correspondence.

To the Editor of Electricity. .

Dear Sir,—I have to inform you that an unauthorised strike by the employees of Messrs. Mann, Egerton and Co., Ltd., who are working on the contract for the electrical re-conditioning of the Government Offices in Whitehall, has taken place. The men have been instructed to return to work by their union, but have refused to obey this instruction.

Under our working rules, as agreed with the union, should any dispute arise no stoppage of work should take place until such dispute has been referred to a joint committee for investigation.

I shall be much obliged if you will insert this in your columns, with an intimation to all employers of electrical labour that, should they require any additional men, they should communicate with me before engaging them.—I am, yours faithfully,

Leonard G. Tate, General Secretary,
National Federated Electrical Association.

October 10, 1923.

Masonic.—The Installation Meeting of the Kelvin Lodge No. 3736 will be held at Mark Masons' Hall on Friday, October 26, at 5 p.m., when Mr. A. Forbes Dick is due to be installed as W.M. for the ensuing twelve months.

Meetings.—The Junior Inst. of Engineers will meet at 39, Victoria Street, Westminster, S.W.1, on Friday, 19th inst. Lecturette : "The Gas Boiler (or Circulator) and Its Application," by F. W. Dye. (Diagrams and demonstrations.) Also on Friday, 26th, lecturette : "Crystals for Wireless Reception," by A. V. Ballhatchet (Member). (Slides and exhibits.) And on Friday, November 2, lecturette : "Hydraulic Propulsion," by D. V. Hotchkiss. (Slides.) All at 7.30 p.m.

B.E.X. Awards.—Certain questions have arisen in regard to the granting of awards at next year's British Empire Exhibition. To meet them the board proposes to do away with awards altogether, and to issue a commemorative medal to all exhibitors. The representatives of the Dominions and Colonies and the Associations organising sections will be asked to ascertain the feeling of exhibitors in their respective sections, and the Exhibition authorities will ascertain the feeling amongst exhibitors in sections which are being organised from headquarters.

A SIMPLE METHOD OF FINDING FAULTS ON CABLES.

The following description of a method of finding faults on electric cables which is in use at the Hereford Electric Light Works is given by Mr. R. W. C. Reeves in the current number of the *Faraday House Journal.*

Though the method appears to be somewhat crude, the author has used it on numerous occasions with success on a D.C. three-wire 400-volt cable network. It is the only method of fault finding used on that part of the system in question, which employs bitumen insulated cables.

The apparatus required comprises a bar of iron, or "drag," about 3 ft. long, a milli-voltmeter, and two lengths of cable. The tackle used by the author consists of a length of 1½ in. single-channel iron, furnished with a substantial brass terminal at one end, a Weston voltmeter reading from zero to 1.5 volts, a steel spike, and two lengths of C.T.S. cable, each about 20 yards.

Assuming that the faulty length of cable has been found by the usual methods, the procedure is as follows :—The "drag" is connected to one terminal of the voltmeter by means of one of the lengths of C.T.S. cable, the remaining length being used to connect the other terminal of the voltmeter to some good earth. A most convenient earth is found in the house service watercocks, usually located in handholes, in the pavements on either side of the street.

One operator holds the voltmeter, while another slowly draws the "drag" along the track of the faulty cable. When the drag nears the fault, usually within a yard or so of it, a slight deflection—in the neighbourhood of 0.05 volt—is noticed on the voltmeter. This deflection increases until the drag is directly over the fault. The drag is now replaced by the spike, which is driven into the ground in several places before and after the point of maximum reading, obtained by the drag, until another maximum reading is obtained. It will be found that the point at which this maximum deflection is shown gives the position of the fault to within a negligible distance of a few inches.

The reason for the phenomenon would appear to be that some of the escaping current runs along the surface of the ground, and the potential will be highest or lowest directly above the fault, depending on whether the leak is on the positive or negative main. An improvement could be made by the use of a central zero voltmeter, as this would instantly indicate the polarity of the fault, without the necessity of changing the leads to the voltmeter.

The chief advantages are :—(1) The tests are carried out without discontinuing the supply ; (2) the apparatus is simple, and in the hands of a reasonably careful operator is very effective ; and (3) a number of leaks on the same cable can be found with ease.

The great disadvantage is that it would be rather difficult of operation in a large town, owing to the inconvenience caused to traffic by the long trailing leads.

Its usefulness is, of course, limited to bitumen insulated cables, "laid solid" or "drawn-in" ducts of some non-conducting material, such as fibre or earthenware.

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A MODERN BOILER-FEED METER.

Both from a scientific and a business point of view, every boiler should be fitted with a hot feed water meter just as it is with a feed valve, a safety valve and a pressure gauge, and, when the necessity of measuring the feed water in this way is recognised, a reduction in the coal bill is bound to follow, probably, on the average, at least 5 per cent. One of the best known, as it is the oldest, boiler-feed meters is the "Kennedy," made by Glenfield and Kennedy, Ltd., of Kilmarnock, who have been well known for over fifty years past in connection with the manufacture of direct acting fluid meters of the "weir," "V" notch, rotary, "venturi" tube and "pitot" tube types for all conditions of temperature, pressure and volume, and not only for hot and cold water, but also for many other liquids, such as oil, benzene, petrol, alcohol, glycerine and ammonia, in addition to apparatus such as the "Barr and Lennox" automatic tank level recorder. The "Kennedy" feed meter consists essentially of a vertical cast-iron cylinder, lined internally with gunmetal, and fitted with a piston actuated by the water pressure so arranged that the travel corresponds to the displacement of a definite amount of water. The mechanism is double acting, by means of a falling hammer weight actuated by a rack at the end of the piston rod engaging with a driving pinion, so that the passage of the water through the meter is continuous and the travel of the pinion is recorded direct in terms of gallons of water by means of a wheel train and a series of dials. These meters are supplied in standard sizes from ½ in. (400 gallons per hour) to 8 in. (24,000 gallons per hour), tested by hydraulic pressure to 500 lb. per sq. in., and will measure water at any temperature almost up to the point of the formation of steam; and the installation can, if necessary, include a by-pass, so that the meter can be tested or taken out of the circuit at any time without stopping the feeding of the boilers.

The amount of back pressure on the pump is very small, about 5-6 lb. per sq. in., depending on the duty, whilst the injector can be used as usual, with the meter on the suction. The meters are of solid construction, and, with reasonable care and attention, should last at least twenty years. Finally, it may be stated that these meters undergo a most rigid system of inspection, adjustment and calibration before dispatch, and their accuracy may be relied upon to 1 per cent., which is almost equal to the accuracy obtainable by the tedious method of weighing water in tanks—a procedure which cannot be adopted for continuous working.

Sweden.—A copy of the *Swedish Economic Review* for the third quarter of 1923 has just come to hand. It contains a survey of business conditions in general as well as special reviews of banking and of the staple industries. From it we note that the general improvement noticeable in trade conditions at the end of last year has continued steadily, and in the electrical industries the order-reserve has benefited from the decision to electrify the railway between Stockholm and Gothenburg.

Finsbury Old Students' Association.—The twelfth annual dinner will be held at the Engineers' Club on Saturday, November 10, at 7 p.m., when the chair will be taken by the President (Mr. W. M. Mordey, M.Inst.C.E., M.I.E.E.). Tickets—10s. 6d. each—may be obtained from the Hon. Secretary (Mr. H. P. Guy), 74, Silver Street, Edmonton, N.18, who will also be pleased to send particulars of the Association to any Old Student of Finsbury who is not already a member.

Reviews of Books, &c.

[Books noticed in this column will be sent from ELECTRICITY *Office to any part of the world, for the published price, plus five per cent. for postage (minimum 2d.), and orders will be appreciated.]*

ELECTRIC WIRING TABLES. By W. Perren Maycock and F. C. Raphael. 4th edition. 96 pp. 4¼ in. by 2¾ in. (Pitman, 3s. 6d.)—Recent changes in standards and alterations in practice which have arisen since the publication of the previous edition necessitated the recalculation and rearrangement of most of the matter in order to bring it up to date. Mr. Raphael has carried out this work and effected some desirable excisions and alterations, so that the edition is a very handy pocket-book of reference on wiring calculations under modern conditions. Further, he has written such an excellent preface, explaining the reasons for the adoption of B.E.S.A. standards, coupled with comparison tables with S.W.G. standards, and the alteration of the several "ready-reckoner" tables to facilitate comparison of price on the bases of 1,760 yd. and 1,000 yd., also of 110 yd. and 100 yd., as well as other matters, that the reviewer finds it somewhat difficult to add much of an original nature—especially as great stress is laid on the fact that the publication purports only to be an easily portable book of wiring tables and not an encyclopædic pocket-book. It is a veritable fund of useful information on all wiring, voltage drop and financial considerations as continually face the installation engineer as regards lamps, motors, domestic appliances, meters, etc., as has been proved by the reviewer carrying it in his pocket and on several cases in quick succession finding in it just what he wanted to know.

RAILWAY SIGNALLING: MECHANICAL. By F. R. Raynar Wilson. 108 pp., 75 figs. (Pitman, 2s. 6d.)—Never before has so much detailed information on the complicated art of railway signalling been presented in book form. English practice only is dealt with and historical matter has been eliminated, with the result that the space available is crammed with really up-to-date technical matter. First the Block system is described, then the lay-out of the signalling and points, position and arrangement of signal-boxes, interlocking, etc. Signal fittings are treated in detail, and at the end the preparation of a signalling scheme is gone into in meticulous detail, together with the principles and examples of interlocking. Thus we get from the general to the detailed, and always find the text amplified by illustrations and diagrams most carefully prepared. Besides railwaymen, that large army which makes the study of railways and railway working an absorbing hobby, will find this primer full of abiding interest and instruction. By reading this book in conjunction with its companion (by the same author) "Railway Signalling: Automatic," the simplicity and flexibility of the electrical system of signalling over the mechanical is clearly brought out. Though not so full of engineering interest, a book on operating conditions in all the countries of the world at the present time would be of general interest.

DISCOVERIES AND INVENTIONS OF THE TWENTIETH CENTURY. By Edward Cressy. 2nd edition. Demy

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8vo. Cloth. 458 pp., 342 illustrations. (Routledge, 12s. 6d. net.)—In 1879, as a boy of 15, the writer was presented on his birthday with a copy of "Discoveries and Inventions of the Nineteenth Century" by Robert Routledge. That book is still a valued possession, and my readers can judge therefore of the keen pleasure with which one welcomes the lineal descendant of the same work after a period of well over forty years. Science has indeed moved with giant strides, and the new book contains well illustrated articles describing discoveries and inventions which are in many cases far beyond the most grandiose ideas of those who contributed to the columns of that early work. Of course, our own science, electricity, in its many applications, is responsible for quite a large amount of space in this new edition; in fact, the word is directly included in six chapter titles out of twenty, and is incidentally introduced in the text in at least four more. The book opens with an instructive chapter on the revival of water-power, followed by sections on "Coal, Gas and Petroleum," "Steam Power" and "Gas, Petrol and Oil Engines." Then we get to the "Generation and Transmission of Electricity," "Electric Lighting" and other applications. Chemistry, agriculture, shipping, aviation and photography, including the wonders of the moving-picture world, are dealt with in detail, and the text is written throughout in a wonderfully clear and explanatory manner which should enable it to appeal to every class of reader who takes the slightest interest in the scientific wonders now forming part of our everyday life; the numerous and beautifully printed illustrations add largely to the intellectual value of the text. Altogether it is a really valuable book of general technical knowledge, and it can be most cordially recommended to our readers. We hope it will meet with a large sale, as that can but advance the technical knowledge of the public in general and give them a better idea of the credit which is due to the great inventors of this and other countries as well as to the skill of the workmen employed in the industries which have grown up through the inventions.

Trade Notes.

Revised conduit price schedule No. 995 has just been issued by **Simplex Conduits, Ltd.**, of Birmingham. They state that an exceptionally wide distribution of copies of this price schedule has been made throughout the trade, but it is possible that quite a number of those who are interested in the revision may have unavoidably been overlooked, and they will, therefore, be very pleased indeed to send copies to all *bona-fide* trade applicants who may write and ask for them.

A thoroughly informative catalogue (No. 150) on their L.T. and H.T. paper insulated cables, has been isued by **Siemens Bros. and Co., Ltd.**, of Woolwich, S.E.18. Another catalogue (No. 595) deals with Siemens accessories for private wireless installations. Included are telephone head sets, loud speakers, aerial and battery protection devices, H.T. and other batteries, accumulators, ebonite materials and parts, insulators, wire, etc.

A booklet describing a considerable advance in the art of sawing metals has reached us from **Edward G. Herbert, Ltd.** (Atlas Works, Chapel St., Levenshulme, Manchester). The improvements are due to the blades being made of high-speed steel, containing 18 per cent. tungsten, and having a patented "set" enabling them to be sharpened many times. A saw grinding machine of novel design which forms the correct shape of tooth is also listed, as is a sawing machine designed to run at a high speed and under conditions enabling the full benefit to be obtained from the blades. It is claimed that the net result is to halve the time and cost of sawing.

Various Items.

For Sale.—An advertiser has for disposal some G.E.C. 37/12 cable. For particulars see small advertisement page.

Dividends.—The directors of the Trafford Park Estates, Ltd., recommend a dividend at the rate of 6 per cent. per annum, carrying forward a balance of £96,000.

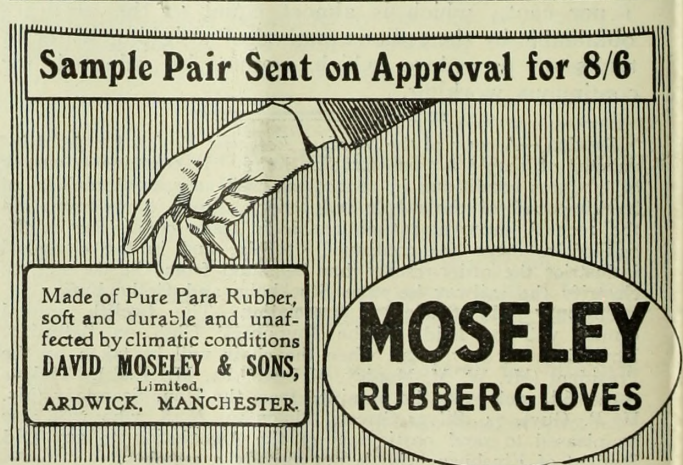
Plant Wanted.—The N.S.W. Govt. Rys. and Trys. invite tenders for the supply and erection of 1,000-kw. sub-station units. Specification, etc., at the D.O.T. (Room 52), 35, Old Queen Street, Westminster, S.W.1.

B.E.X.—The London Electric Firm, of Brighton Road, Croydon, inform us that they have taken space at the British Empire Exhibition, and will show all varieties of their searchlights and similar plant, for which they have held a high reputation for so many years.

Smoking Concert.—The first Electro-Harmonic "smoker" of the season was held at the Caxton Hall on the 12th inst., and there was a very fair attendance considering the inclement weather. The programme was excellent, and that, combined with the more hopeful trade outlook, seemed to make everyone much more cheerful. Let us hope most sincerely that our optimism will be fully borne out by events.

The Kelvin Lodge Ladies' Festival.—The annual Ladies' Festival of the Kelvin Lodge, No. 3,736, was held at the Connaught Rooms on Friday, October 5, when the W.M., Mr. Philip C. Ebner, and Mrs. Ebner received and welcomed a party of well over one hundred members of the Lodge, their wives and friends, and an enjoyable evening was spent by all those present. An excellent musical programme was provided by W. Bro. Ralph Norris, and each lady received as a gift a charming memento of the occasion as well as a box of chocolates. Altogether it was just the happy sort of evening for which this well-known electrical lodge has gained such a reputation.

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A POPULAR SCIENTIFIC WEEKLY JOURNAL
ELECTRICITY
A PRACTICAL TRADE JOURNAL

OCTOBER 26, 1923.

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ELECTRIC CABLES FOR LONG-DISTANCE TRANSMISSION.

By G. W. Stubbings.

The transmission of large amounts of electric power over considerable distance can only be economically carried out by the use of very high voltages. Such transmission has been largely developed in America by the use of overhead lines, the geographical and meterological conditions of the country being suitable to the use of a system where the insulation of the line for very high voltages does not present more than ordinary difficulty. The development of the call for long-distance transmission in this country has not been accompanied by a general use of overhead lines, as the comparative congestion and meterological conditions have long been recognised as militating against the use of this method. The problem of the design of cable for operating at voltages in the neighbourhood of 50,000 has engaged the attention, not only of the cable manufacturers, but also of scientists, for many years. The problem is complicated by the fact that the fall of potential through the layer of insulating material between the charged conductor and the earthed lead sheathing is not regular, but is concentrated on the layers adjacent to the conductor. At very high voltages, therefore, increasing the thickness of the insulation would have a relatively small effect on the potential stress on the portion near the conductor. Early proposals were made to equalise this concentration by varying the composition of the insulation throughout the thickness. According to theoretical principles this concentration would be relieved by making the interior layers of insulation of a substance having a higher specific inductive conductivity than the outer layers. Such cables, known as graded cables, were manufactured in experimental lengths. The difficulty in securing the exact composition of the various grades of insulation in manufacturing processes, and the risk of change in the composition of these grades after the lapse of time, prevented these cables ever being used. A further suggestion to relieve the concentration of the inner layers was by interposing between the conductor and the outer layer of the insulating material a conducting sheath maintained at the potential that would exist if the fall of pressure through the thickness of the insulation were uniform. This sheath would be maintained at the requisite voltage by being connected to a suitable tapping on the transformer feeding the high-voltage line. Since this voltage would be different from that existing in the insulation under modified conditions, it follows that a capacity current would flow through the sheath. This scheme, although sound theoretically, necessitated a complicated cable, and tended to destroy that simplicity of gear that is usually considered a *sine qua non* where very high voltages are in use. The intersteath method of grading cables, as it is designated, has not therefore matured as a normal solution of the high-voltage cable problem, the prevailing present tendency being to construct a cable for these pressures on the same lines as those orignally in use, taking special precautions in manufacture to meet the stringent conditions of working. Recent researches on the characteristics of insulating materials have shown that the dielectric strength or breakdown pressure per unit thickness largely depends upon the degree of homogeneity and upon the presence of minute traces of moisture. Modern cables for extra high voltages are, therefore, insulated with paper which is impregnated with insulating oil by improved processes designed to ensure the expulsion of all air spaces in the paper and the elimination of the last traces of water. Cable manufacturers are now able to supply three-core cables for working pressures of 50,000 volts alternating between cores. It is possible that above this voltage three-core cables may no longer be practicable, on account of the excessive size and consequent difficulty in handling, and that single-core cables may be necessary. In view of the increased losses in the sheathing of single-core cables, and of the difficulties in laying them, there is no doubt the attention will be concentrated upon the raising of the voltage limit of three-core cables.

An interesting development of the intersheath method of grading cables has lately been put forward by A. M. Taylor. This method proposes to use the intersheaths not merely to anchor the dielectric potential, but also to carry power currents. This is accomplished by using the various parts of three six-phase systems to tie the potentials of triple concentric cables. The advantage claimed for the system is that exceedingly high voltages can be used, and that the power currents in the intersheaths being combined with the capacity currents required for potential equalisation, are partially neutralised by these latter, at any rate as far as the lagging wattless component is concerned, and that consequently these currents are transmitted with great economy. The proposals have been very much criticised on the score of great complication of the switching gear required and the intricacy of the high-tension connections. It has also been pointed out that, as the intersheaths carry power current, only a portion of the total power is transmitted at the high voltage. In spite of the criticisms, it seems, however, that the proposals form a useful

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contribution to the solution of the problem of long-distance transmission in this country.

The history of the development of cables for extra high voltages affords an interesting case where an exceedingly attractive scientific solution of an engineering problem has been found unsuitable or of questionable utility on account of the complications and difficulties in working which would be entailed by its use. As transmission voltages increase, the necessity for simplicity in the high-tension arrangements is generally considered to increase correspondingly, and for this reason it is probable that further advance will be accomplished by a careful study of the characteristics of dielectrics rather than by the development of extraneous and artificial means of reducing the potential gradient.

THE IMPERIAL ECONOMIC CONFERENCE.

B.E.A. Memorandum.

After expressing sympathy with the objects of the conference, a memorandum sent to the President of the B.O.T. by the British Engineers' Association states very clearly its attitude with regard to several matters of the greatest importance to manufacturers. For example, the association undeniably proves the case for the desirability of exercising intelligent discrimination in the conditioning of our foreign loans with the object of preserving and developing our *skilled industries*. That such a policy is not impracticable is shown by the fact that, in the U.S.A. and in France, foreign loan contracts almost invariably contain conditions safeguarding the interests of home industries.

Now the opponents of "intelligent discrimination" urge that all foreign and Colonial loans obtained in London must inevitably cause an equivalent demand for British goods. For example, some Dependency of the British Crown may want to purchase, say, 50 locomotives from some Continental State with money borrowed in London. This can only be effected by England sending directly to that country sufficient goods to pay for these locomotives, or indirectly, by sending goods, say, to France, to pay for wine or other produce required by the country making the locomotives.

This argument, however, ignores the very different *qualities* of the various industries and trades, as measured by their effects on the standard of life and the moral qualities of the people engaged in them. It makes no distinction between skilled and unskilled or desirable and undesirable occupations. It is true that locomotives, electrical machinery, and other products of skilled labour purchased outside Great Britain with money borrowed in London would ultimately be paid for directly or indirectly by visible or invisible exports from this country. But the intervening international transactions might, and usually would, be very complicated and prolonged. It is scarcely necessary to emphasise the importance of the time factor in trading transactions. The highly skilled products of the engineering industry might have yielded a handsome profit to our foreign competitor favoured with the order, financed with our money, but it might so happen that by the time our counter-balancing export orders were executed, trade might be in such a condition that our goods had to be sold without profit, or even at a loss.

Even ignoring that contingency, we might find ourselves in the position of paying for locomotives, turbo-generators and scientific instruments with pig-iron, rails, slop clothing and the cheapest classes of pottery ware. Such international exchanges might possibly help to enrich a few individuals, but they could not possibly be profitable to the nation, and if they were indulged in on a large scale they would soon impoverish this country and depress the standard of living of our people.

With regard to Imperial Preference, the memorandum cogently argues that as no human mind can grasp world trade conditions and requirements in the present unsettled state, and, if they were comprehended, no single nation could control them, it might be more practical and fruitful to devote closer attention for the time being to the conditions in Great Britain within our own control, and to those in our Empire overseas on which we could exercise a powerful influence.

We are in urgent need of markets, and because it should help us to hold and develop important markets within our own Empire, where we have big vested interests and the welfare of our own race is deeply concerned, the B.E.A. are strongly in favour of effective Imperial Preference being extended to British manufacturers. By "effective Imperial Preference" they mean a preference which will not only give us an advantage in normal competition, but also protect us from grossly unfair competition due to abnormal economically unsound conditions in another manufacturing and exporting country.

PAINTS AND VARNISHES FOR INDUSTRIAL WORK.

That modern industrial paints, varnishes, japans, enamels, etc., as well as electrical insulating varnishes and enamels, have attained such a high state of perfection as regards lasting qualities, appearance and ease of application is due to the establishment of technical laboratories and the constant employment of chemists devoting their whole time to the investigation of industrial processes by such old-established firms as Messrs. Jenson and Nicholson, Ltd., of Goswell Works, Stratford, E.15, who have been engaged in the business since 1821. The present wide range of products made by this firm, who during the whole 102 years of their existence have steadfastly adhered to "all-British manufacture" cover the requirements of every industry, at least so it appears to us from a perusal of their new booklet on industrial varnishes, japans, enamels, etc. Included are several rust preventatives and acid-resisting materials, coverings for spools, varnishes for tarpaulins, etc.

To electrical engineers the booklet on electrical insulating varnishes, enamels, etc., cannot fail to be of the greatest interest, as the ranges of "Lacwatt" insulating varnishes and impregnating compounds, "Coilac" finishing varnishes, "Miclac" mica varnishes, "Corlac" core plate varnish, acid-proof enamel, etc., are exhaustive.

A copy of either of these booklets will be sent to interested readers on proper application to Messrs. Jenson and Nicholson, Ltd.

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RADIO-FREQUENCY AMPLIFICATION.*

By A. Chenik.

Radio-frequency amplification is a matter which, to the majority of wireless experimenters, must have caused a good deal of anxious consideration, and it is in the hope that these few remarks will tend to assist those who have been in doubt on some obscure point that these words are written.

There are two methods of increasing the strength of received wireless signals. We can either add to an ordinary receiver a low-frequency amplifier, which will strengthen the actual audible signals obtained, or we may amplify or strengthen the incoming high-frequency currents before applying them to the detector. This last method, commonly known as high-frequency amplification, or radio-frequency amplification, is particularly useful for receiving feeble signals.

Since a thermionic valve will repeat in its plate circuits, with increased amplitude, currents of any frequency impressed on its grid, it may be used as an amplifier of either radio or audio frequencies, in conjunction with some detecting device, preferably another three-electrode valve. If amplification is desired at radio frequencies, the radio-frequency amplifying valve is connected in such a manner as to build up the incoming signal before it reaches the detecting device, while for audio-frequency amplification it is connected in such a manner that it receives the incoming signal after detection. The general trend of present-day wireless seems to be toward decreased power at the transmitting station and increased sensitivity at the receiver, and at the same time toward the spanning of great distances with a minimum of power. It is in these instances that the effectiveness of radio-frequency amplification is most appreciated, and with it we will be concerned in this paper.

For success, two conditions should be fulfilled: The characteristics of the signal itself ought not to be changed except in amplitude; and only the signals which one desires to receive should be magnified. Generally, for financial reasons, and for the reason that the experimenter wishes to secure the best results with the minimum of apparatus, the smallest number of valves, consistent with the distance it is desired to cover, is used. This is desirable, for the difficulties of distortionless amplification of telephony in particular increase rapidly with the number of valves. Now, a detector requires a certain strength of high-frequency current to operate it effectively, and the rectified current available for operating the telephone receivers or the loud-speaker is proportional to the square of the high-frequency current applied to the detector. In other words, if we double the strength of the high-frequency current, we will get four times the rectified current, and therefore four times the signal strength. Similarly, if we can multiply the strength of the high-frequency current by three, we will get nine times the rectified current available for operating the telephones. It will therefore be appreciated that high-frequency amplification is of very great value. There is the additional advantage in the case of the reception of wireless speech or music, that distortion of the speech is far less likely in the case of a high-frequency amplifier than in the case of a low-frequency amplifier. The latter usually employ iron-core transformers, which tend to spoil the quality of the speech, particularly if more than two transformers are used. This is due to the iron in the transformer.

High-frequency voltage amplification must come before rectification, and the arrangement of the apparatus associated with the valves which form the H.F. portion of the receiving gear requires careful design and handling if good results are to be obtained. Valves are essentially voltage-operated devices, and it is necessary to maintain as high as possible the signal voltages on the grid in order that the strongest possible potential changes will be produced in the anode side of the valve. Large potentials can more easily be produced across the input (grid-filament) circuit the higher the grid-filament impedance, and at the low wave-length upon which telephony is transmitted, great care must be taken to keep the capacity across the input circuit as small as possible. It is better to employ amplifying valves with low capacity and stray capacity such as that caused by long leads, and self capacities in apparatus should be reduced to a minimum. Practically every wireless experimenter will have some idea of how a valve acts as an amplifier. By applying varying voltages to the grid of a valve it is possible to obtain a variation of the steady current which normally flows from the filament to the anode or plate of the valve in the form of electrons and then round the anode circuit. If we apply oscillating potentials to the grid of a valve by connecting a circuit containing an oscillatory current across grid and filament, the varying grid potentials will set up large variations of current through a similar oscillation circuit in the anode circuit of the valve. These varying currents in the anode circuit set up large changes of potential or voltage across the oscillatory anode circuit, and these potentials may then be applied to the grid circuit of the second valve, which valve may be used either as a detector or rectifier of the oscillations (in which case a leaky grid condenser is usually connected in the grid circuit), or as another high-frequency amplifier. It is to be noted that in the case of valve amplifiers the grid circuit is only concerned with current changes which, in turn, set up potential variations, these variations being communicated to the grid circuit of the second valve. The problem we are now concerned with is, how to cause the large variations of anode current of the first valve to produce corresponding changes of potential applied to the grid of the second valve. If we connected a circuit in which oscillatory currents were flowing across the grid and filament of a three-electrode valve and simply connected a high-tension battery across the anode and filament accumulator, while we would get changes of anode current exactly corresponding to the currents in the grid circuit, only larger, yet there would be no potential variations which could be applied to the grid of a second valve. To get these potential variations we have to include some piece of apparatus in the anode circuit of the first valve of such a kind that when the oscillating currents pass through it, potential variations are produced which may be applied to the grid of the second valve.

It is well known that if a direct current is passed through a resistance, a potential difference will be set up across that resistance, which potential difference will depend upon the current flowing through the resistance, *i.e.*, if the current is increased the voltage

* Paper read before the S.A. Inst. of Electrical Engineers.

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across the resistance will also increase. In the same way, if oscillating currents are passed through a resistance, varying potentials will be set up across the resistance. This immediately suggests that we might include a high resistance of, say, 50,000 ohms, between the anode of the valve and the positive terminal of the high-tension battery.

The high-frequency currents flowing in the anode circuit would pass through this resistance and set up large potential variations across it, and by connecting the grid of a second valve to one end of this resistance and the filament to the other end, it would be possible to couple two valves so as to get the desired effect. If we pass a steady current through an inductance coil having negligible resistance, there will be no potential difference across the ends of the coil. If, however, we pass a varying or oscillating current through such an inductance coil, or impedance, as it would be called, potential variations will be set up across the coil, the potential of one end of the coil with respect to the other end depending upon the nature of the change of current and its amount. This suggests that we might include an inductance coil in the anode circuit of the first valve connecting one end to the grid of the second valve and the other end to the filament of the second valve. The large variations of current in the anode of the first valve caused by passing through the inductance coil would set up oscillating potentials across its ends, and these would be communicated to the second valve, which might be acting either as a detector or as another high-frequency amplifier. If now we choose to pass the anode current of the first valve through an inductance shunted by a variable condenser, we can set up oscillating currents in the oscillation circuit formed by the inductance and the condenser. If we are to get amplified currents in the anode oscillation circuit we must tune this circuit to the same frequency as that of the currents in the grid circuit of the first valve. Putting it another way, the anode oscillatory circuit should be tuned to the same wave-length as the incoming signals. Under these conditions strong anode circuit oscillations are set up, and these, by flowing in the anode oscillatory circuit, will set up potential variations across the oscillation circuit, which may be included in the grid circuit of a second valve. Instead of doing this, however, we might couple the anode oscillatory circuit of the first valve to another oscillation circuit in the grid circuit of the second valve.

Now let us consider in greater detail the exact method of utilising the aforementioned principles, and to make the position clearer I have sketched some diagrams which show the difference in the methods which may be adopted. I would like to state at the outset that the choice of one or other of these methods of coupling valves will depend on whether reaction is going to be used or not. Also it is to be understood that there are two standards by which usefulness may be judged. One either commends a circuit for its efficiency or for its simplicity of operation. In some cases simplicity of operation is essential, and in these cases it is usual to lose a certain amount of sensitivity. These various points will be raised later, but there is one further point which should be mentioned here, and that is in connection with inductances.

Inductances may be either fixed inductances or they may be variable, in which latter case it is possible to vary them in stages, as, for example, by taking tappings every few turns. On the other hand, it is only possible to obtain an inductance which is smoothly variable—that is to say, one which may be accurately adjusted, such as the inductance with a sliding contact, or better still, the variometer. A simple inductance which has no condenser across it to form an oscillation circuit is very often called an "aperiodic coil." This implies that the inductance does not possess natural selectivity, whereas an oscillation circuit, consisting of an inductance, shunted by, say, a variable condenser, does possess very distinct selective properties. One does not have to work very long with valves before realising that a simple inductance is not absolutely aperiodic. Practically every inductance has a substantial amount of what is known as self-capacity, which is due to the proximity of the different turns of wire, this proximity resulting in a condenser effect between the turns. This self-capacity, combined with the inductance, completes an oscillation circuit with some of the selective properties of the ordinary kind of circuit employing a separate external condenser shunted across the inductance. Apart from the self-capacity of the plain inductance coil, there is always an additional condenser effect when a plain coil is connected in the grid or anode circuit of a valve. Take, for example, the case of a coil connected in the anode circuit of a three-electrode valve. On one side it is connected to the anode of the valve, on the other it is connected through the high-tension battery to the filament of the valve. The anode and filament form a very small condenser, which, shunted across the inductance, produces what is really an oscillation circuit. This oscillation circuit will have what is known as a natural wave-length—that is to say, it will tend to pick up currents of a given frequency more readily than currents of different frequency. If the inductance coil had no capacity whatever across it, it would not be selective to any particular frequency, and it would be possible to induce in the coil currents of widely differing frequency. The fact that the inductance coil used in an ordinary valve circuit is not perfectly aperiodic is of great importance, though a tuned circuit having a separate condenser is more selective. We can look at the question from rather a different standpoint and consider that we are passing a high-frequency current through different pieces of apparatus, the high-frequency variation being due to the high-frequency currents flowing in the anode of a three-electrode valve. The essential value of the apparatus which we are to include in the anode circuit depends upon the maximum potential variations which we can get out of it and apply to the grid of a second valve. The efficiency of the inter-valve coupling is measured by the magnitude of the potential variations which are communicated to the grid of a second valve.

(To be continued.)

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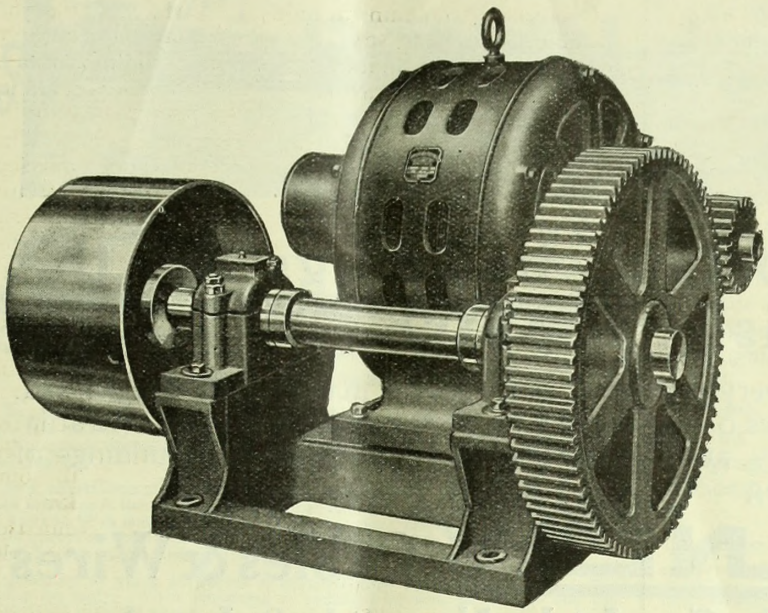


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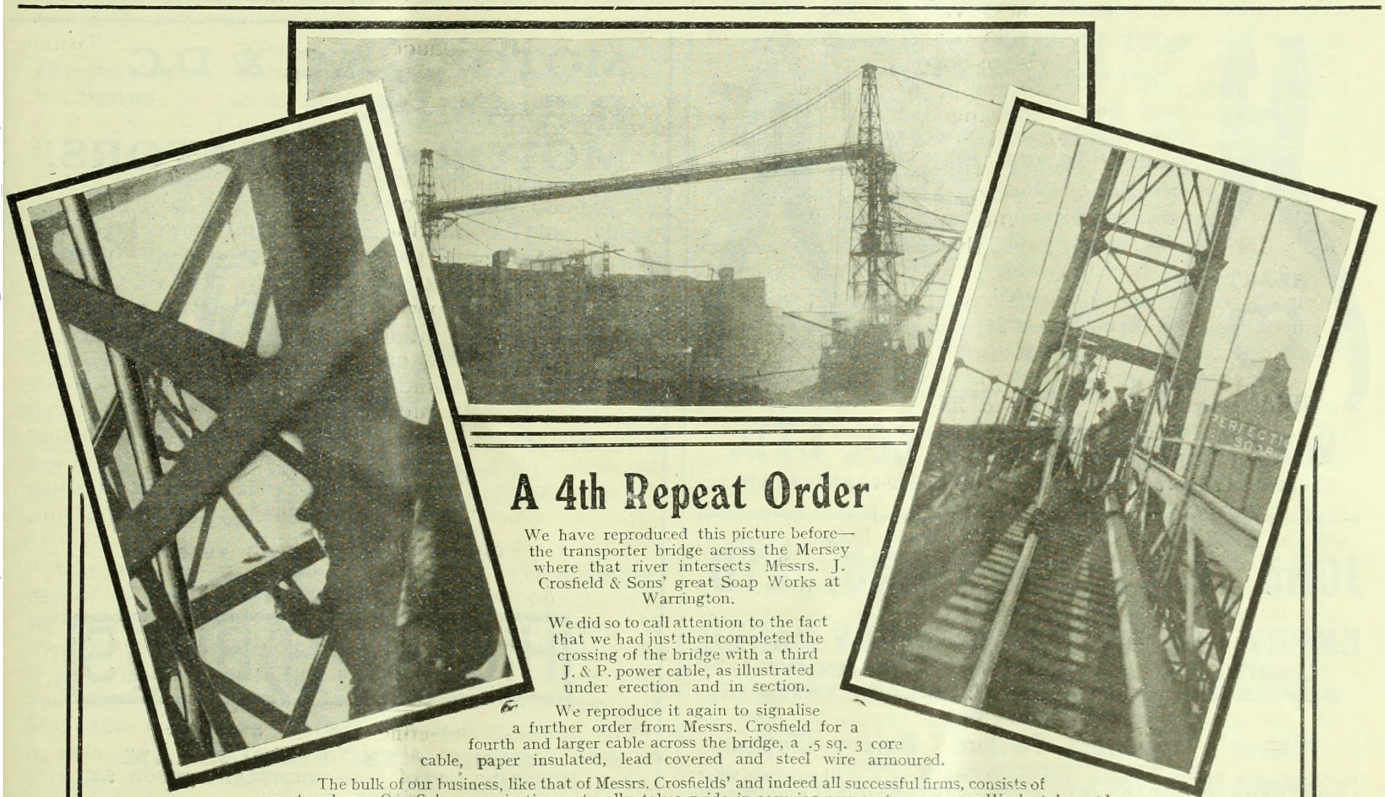
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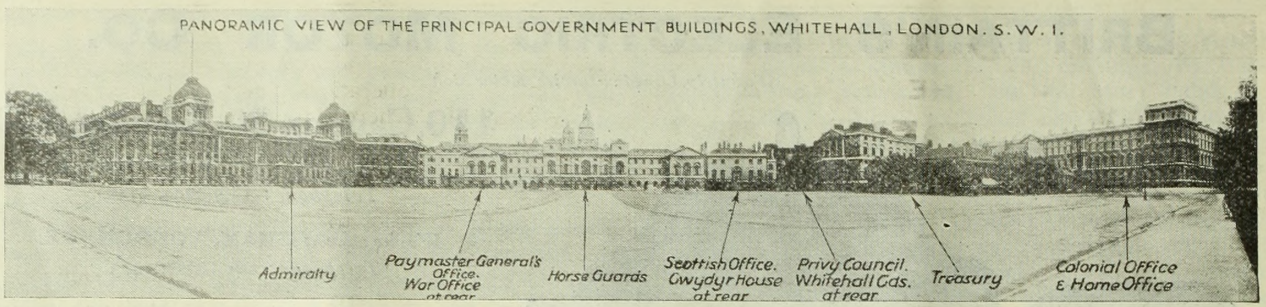
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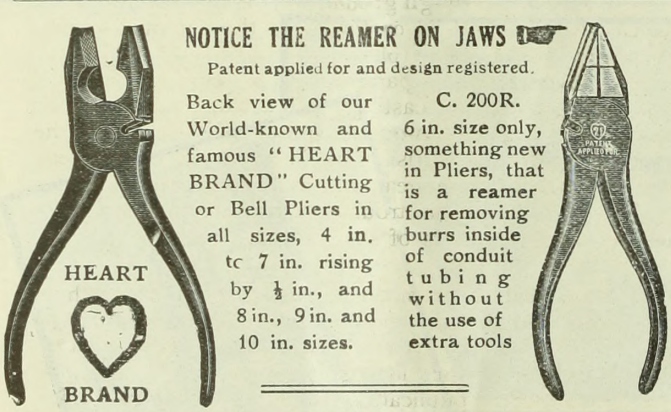
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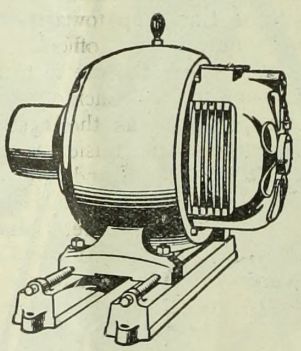
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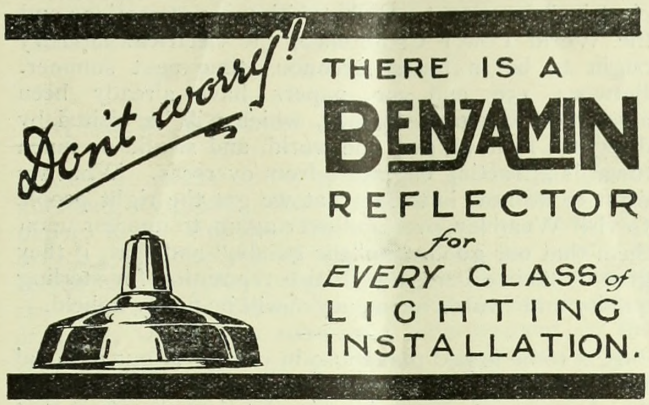
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Current Topics.

The Breakdown Season.

Electricity supply failures still continue to be recorded each week, among the latest areas to suffer from this inconvenience being Palmers Green, Winchmore Hill, and Southgate, where the supply was totally interrupted for upwards of an hour last week. A temporary failure of the supply in Fleet Street, the centre of newspaper land, extended from Shoe Lane, up towards the Strand, and included several newspaper offices. That ancient hostelry, the "Cheshire Cheese," was in the area affected, but was able to fall back upon its alternative, gas lighting. As recently as the 15th of this month a considerable portion of the busiest area served by the Charing Cross and West-end and City Electric Supply Company was also affected by a breakdown, attributed to a feeder cable. The failure, which, as usually happens, occurred at the busiest portion of the evening, lasted upwards of three quarters of an hour, and caused considerable congestion, especially in connection with the theatre traffic.

We really cannot afford these gratuitous advertisements of the unreliability of electricity supply, and whilst making every allowance for the unforeseen, the average of breakdowns is far above what it should be if all public supply systems were properly looked after and the plant and distributing system maintained in first class condition. There is surely something rotten in the state of Denmark when one can hardly pick up a daily without coming across some reported failure of electric light at a critical period and in a congested area. This kind of thing gives the gas interests just the gratuitous advertisement they are looking for, and must do the cause of electric lighting immense harm in the aggregate.

By Way of Contrast.

By way of contrast in the matter of electrical reliability, an interesting fact emerges from the rescue operations at the Redding Pit, where, as will be recalled, emergency electric pumping plant was rapidly installed to deal with the flood water. One of the earliest pumps to be pressed into service was a submersible electrically-driven pump of German origin, which had been lying, for some considerable time previous to the disaster, in a scrap heap in the yard of a near-by colliery. When the Redding Pit was flooded, this old pump was dragged from its hiding place, and immediately lowered into the shaft and placed in commission, pumping out water at the rate of some hundreds of gallons per hour. For eight or nine days, so the story goes, that derelict Hun plant stuck gamely to its task, and never gave the slightest trouble. It was in continuous operation the whole of the time, and was simply left to look after itself whilst hurried preparations were made to instal additional pumping plant of British manufacture and greater capacity.

I understand that during the whole of the operations more or less serious trouble has been experienced with the more modern pumps, possibly owing to the fact that their completion had to be rushed through, and that they were subsequently by no means gently handled in placing them in position. As a matter of fact, an onlooker of my acquaintance told me that one very heavy pump, on arrival at the colliery entrance, was simply hitched on to haulage tackle, and dragged bodily across the rough ground to the shaft head, much to the detriment of its casting. In the act of lowering it again found some obstruction, and when hauled back proved to have parted with a considerable slice of one of the main castings. The fact remains that several armature burn-outs resulted in the case of the electrically-driven British pumps at Redding, whereas the original German gear worked continuously, under water, and gave no trouble whatever. An object-lesson for the makers of such plant.

Wireless "Pirates."

A good deal of prominence has been given, both in the Press and through the medium of Broadcasting, to the tremendous rush of applicants for listening-in licences since the publication of the Advisory Committee's long-awaited Report. To my mind it savours of "cheek" to term these recent applicants "pirates," inferring that it is only by threat of possible legal consequences that they have been prevailed upon to contribute their quota to the cost of the Broadcasting entertainments. After all, the nation has waited patiently for upwards of six months for the very prolonged deliberations of the Committee, and the main reason that ninety per cent. of these people have not previously applied for licences was undoubtedly the state of uncertainty prevailing as to the terms on which amended licences would be issued.

Thus the so-called "pirating" really has its origin in the dilatoriness of the officials constituting the Post-master-General's Committee, duly appointed by him, and in no sense is it the fault of the large numbers of possessors of apparatus who were waiting to see which

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way the wind blew before investing their money in the general scheme of Broadcasting. Thus the term "pirate" used in this connection is a gratuitous insult, and I think it speaks volumes for the honesty and promptitude of those who *have* taken out licences within the last month that they have lost no time in complying with the conditions immediately the intentions of both the P.M.G. and the B.B.C. were made known to them. The settlement of this vexed question of constructors' licences has undoubtedly given a fresh filip to the trade in Broadcasting sets and apparatus, and the present season looks like repeating the boom results of last winter. Now we know where we are, there is little doubt that many more thousands will go in for this extremely cheap class of enjoyable entertainment.

During the past week another new station has been opened by the B.B.C. at Bournemouth, and I was again fortunately able to listen-in to the opening speeches of Mr. Reith, Lord Desborough, and Viscount Burnham, as well as to enjoy selections of excellent orchestral music played by the local musicians. I can assure those of my readers whose experience of listening-in up to the present has been confined to public demonstrations and possibly a none too efficient set at some friend's house, that, given a well-designed installation, a reasonably good aerial, and a location well away from electric tramways and other similar disturbing influences, the entertainments provided by the B.B.C. are well worth listening to, and in no sense comparable, as some people imagine, with the reproductions of a third-rate gramophone. On a good loud-speaker, like the Claritone, for example, the received music and speech can be as clear as if the performers were actually in the room, and there is a total absence of that disagreeable scratch effect inseparable from most gramophone reproducers.

An Unhealthy System Ousted.

At last the Lambeth Borough Council has sanctioned the installation of electric light, and low pressure hot water heating to replace the existing gas lighting and heating in the Coroner's Court and Mortuary at High Street, Lambeth. Excluding the initial capital expenditure, an annual saving of £40 a year is expected to result from the change. It will be recalled that the Coroner, Mr. Ingleby Oddie, commented, very severely, some time ago on the extremely unhealthy and even dangerous character of the internal atmosphere of this court arising out of the use of unvented gas radiators, and the contemplated change will be welcomed by all whose business brings them to this court.

B.E.X. 1924.

Last Monday I paid another visit to Wembley, and was delighted to see the steady progress which had been made since I was there a few weeks ago. The Machinery Hall, in which I was more particularly interested, will be a truly magnificent sight when it is filled with the exhibits of our great industry, and as about 95 per cent. of the space has already been allotted, there is no doubt it will be filled to overflowing; so any who are hesitating had better move promptly or the opportunity will be lost. Another good point is that E.D.A. has raised the cash necessary for the scheme for a large-scale popular electrical exhibit as well as for an electrical restaurant, so what with these attractions and the World Power Conference, the electrical industry ought to be in for a strenuous time next summer. Between 150 and 200 papers have already been arranged for the conference, which will be visited by delegates from all over the world, and should do much towards attracting engineers from overseas. What we want to do now is to see that we get the right people to visit Wembley, over and over again, to impress upon them that our goods are "the goods," and that, if they give us their orders, the British reputation for sterling quality and "value for money" will be firmly upheld.

Paper Money.

It is to be hoped that those in charge of our national affairs will not yield to the insidious arguments which are being circulated to the effect that inflation of our currency is the cure for unemployment, bad trade and every other evil in our economic structure of to-day. "Not wholesale inflation," say the tempters, "but just moderate, sane inflation." "Sane" inflation, they argue, will relieve unemployment, because it will increase the value of goods and thus give firms an incentive to manufacture products of all descriptions.

To discuss inflation fully would require a bulky tome, but there are a few basic facts which need no explanation and admit of no argument. In the first place, inflation means printing more paper money than is backed by the gold reserve of the country. In other words, inflated paper currency could not be paid in full, and, the greater the inflation, the greater the proportion of the currency which is paper—and nothing more than paper. Inflation is simply another name for depreciation of the currency. Any history book will remind you, if you do not remember, what misery has followed depreciation of the coinage in the past.

Inflation *will* raise the value of goods—of course it will! Any material thing is worth more in terms of paper than it is in terms of gold—more in marks than in terms of our Treasury notes, the value of which we have built up so painfully. And, of course, as the value of goods rises, so does the cost of living, and therefore the cost of wages. The vicious circle begins anew, and the worker can never catch up with the soaring prices produced by inflation. There is no such thing as *sane* inflation. Inflation breeds inflation, and the further one goes along that perilous path, the more painful and difficult is the return; but return we must, sooner or later. Thus business in Germany is still based on gold mark values, which are multiplied by some hundreds of millions to arrive at the paper mark price of the day. Prices and wages—in paper—are alike fabulous, and the worker is always behind. Yet the gold mark or direct barter of goods remains, and must remain, the true basis of trade and payment, and the troubles which Germany has gone through during the past few years are as nothing to the rigours which must accompany the inevitable deflation.

By grim application to the task of paying our way we have raised our paper currency to nearly its face value in gold. Let us never surrender the fruits of our labour for the sake of a respite which could only be temporary and would even then be only apparent. Paper money cannot buy prosperity.

ELEKTRON.

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TELEPHONE PROGRESS IN THE MANCHESTER AND S.E. LANCS DISTRICT.

By Mr. W. J. Medlyn, Superintending Engineer.

A report on the above, by Mr. W. J. Medlyn, Superintending Engineer, shows that the number of telephones in the area rose from 32,946 in 1912 to 56,645 in 1923, an increase of 23,699, or 72 per cent., in eleven years; 7,802 telephones were provided during the year ending September 30, with a net increase of 4,665, which is a substantial improvement on the results obtained during the "boom" period of 1919-20.

During the past eleven years the total underground wire mileage has risen from 75,476 to 182,148, an increase of 141 per cent.

Work on the new cable to Birmingham is well advanced, and the section between Manchester and Macclesfield has recently been brought into use. An additional cable is also being laid to improve the service between Manchester, Disley, New Mills, Whaley Bridge and Buxton. The work of providing an additional cable, containing 160 lines, between Manchester and Liverpool is well advanced. An underground service is being extended from Oldham to Leeds to improve the service between Manchester and the Yorkshire centres. A new cable from Manchester to Glossop is nearly completed, and the extension of the pipe track from Eccles to Atherton and Leigh is approaching completion. The laying of six additional pipes between Manchester and Stockport has recently been completed. A new pipe track has been completed for extending the Manchester-Warrington cable to Northwich. A scheme for direct underground between Manchester, Wigan, Ormskirk and Southport is included in next year's programme.

In addition to main-line communications, many large extensions of the underground system serving local telephone subscribers have been effected, and the work is still steadily progressing.

Concurrently with the extension of the underground system, overhead wires have been re-covered to the extent of 13,066 miles in the district.

The report states that the desire of the Post Office to improve the telephone service for the benefit of the community generally is now fully recognised by the Corporations and other public authorities throughout the district, and their co-operation in affording the requisite facilites for carrying out the work is much appreciated.

Wireless Insurance for Landlords.—It will be recollected that Wireless Insurance for owners and users of wireless sets was originated by the Liverpool Marine and General Insurance Co., Ltd., of Liverpool, and 7, Angel Court, Throgmorton Street, London, E.C.2. The policies insure the apparatus and aerial and also third party risks for the sum of 7s. 6d. per annum. It has been found, however, that there is also a demand for some form of protection for landlords who wish to be compensated for damage done to their property by ill-fixing and using of a wireless set and aerial. In many cases where the occupier is a tenant the landlord is refusing permission for these erections by the tenant until some legal form of indemnity or obligation is given. To meet this difficulty the above-mentioned company has prepared the Landlords' Wireless Protection Policy, the premium being 5s. per annum if one of the company's special wireless policies is held, otherwise 7s 6d. It would usually be payable by the tenant. We consider that all wireless enthusiasts who have not done so should most carefully consider taking up one or preferably both of these policies.

THE SUCCESS FAMILY*.

"The father of Success is Work, the mother of Success is Ambition; the oldest son is Common Sense.

"Some of the other boys are Perseverance, Honesty, Thoroughness, Foresight, Enthusiasm and Co-operation.

"The oldest daughter is Character, some of the sisters are Cheerfulness, Loyalty, Courtesy, Care, Economy, Sincerity and Harmony.

"The baby is Opportunity. Get well acquainted with the 'old man' and you will be able to get along pretty well with all the rest of the family."—Robert Dollar.

ELECTRICAL ENGINEERING—FINAL GRADE.

Solutions to 1923 Examination Questions of the City and Guilds Institute.

By Edward Hughes, B.Sc. (Eng.), A.M.I.E.E.

(*Continued from page* 553.)

Q. 8.—Explain what happens in an alternator on a sudden short-circuit. What is the synchronous impedance of an alternator and how would you calculate it?

A. 8.—When an alternator is suddenly short-circuited the total e.m.f. induced in the stator winding is available to send current through the impedance of that winding. Since the resistance of an alternator winding is always small in comparison with its reactance, the short-circuit current lags nearly 90 degrees behind the generated e.m.f., and therefore tends to weaken the field. But owing to the fact that this current grows very quickly, heavy currents are induced in the field and damping windings and in the solid parts of the magnetic circuit, trying to maintain the flux at its original value. Consequently the S.C. current increases to a value determined mainly by the reactance of the winding and the e.m.f. generated at the instant that the machine was short-circuited,

$$\left.\begin{array}{l}\text{i.e., maximum value}\\ \text{of S.C. current}\\ \text{per phase}\end{array}\right\} = \frac{\text{Initial e.m.f. per phase}}{\text{Impedance per phase}}$$

$$= \frac{\text{Initial e.m.f. per phase}}{\text{Reactance per phase}} \text{(approx.)}$$

Now, in high-speed alternators, there are comparatively few conductors, and the reactance per phase is consequently small; so that when such machines are short-circuited, the current has been found to increase to more than 20 times the full-load current.

With the decay of the eddy currents induced in the field and damping windings, the heavy armature reaction of the lagging S.C. current weakens the field, and the magnitude of the S.C. current decreases until it settles down to a steady value of the order of three times the full-load current.

The maximum value of the S.C. current can be reduced by connecting external reactances in series with the alternator or by designing the stator so as to have a comparatively large leakage flux and therefore a high reactance.

* *Telephony*, Chicago.

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The *synchronous impedance* of an alternator is a quantity that combines the effect of armature reaction with the true impedance of the winding. It is calculated from the readings taken on open-circuit, and on steady short-circuit tests; thus curve *A* in Fig. 13 gives the variation of open-circuit voltage per phase with the

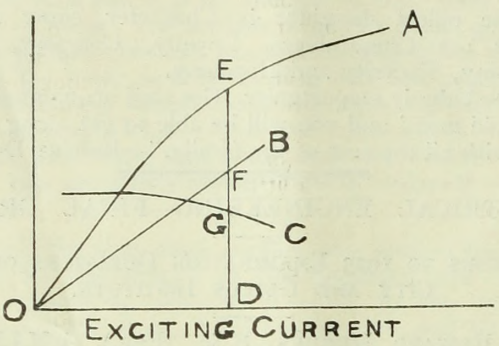


Fig. 13.

field current, whilst curve *B* gives the variation of the steady S.C. current per phase with the same quantity. Then for any exciting current *O D*,

synchronous impedance per phase

$$= \frac{\text{Corresponding O.C. voltage per phase}}{\text{Corresponding S.C. current per phase}}$$

$$= \frac{D\,E}{D\,F}$$

and is represented by *D G*.

By taking different exciting currents, a number of values for the synchronous impedance can be calculated and plotted as shown by curve *C*. It will be noticed that the synchronous impedance is not a constant quantity, so that the value used for calculation purposes should be that corresponding to the normal excitation of the alternator.

(To be continued.)

Questions and Answers by Practical Men.

RULES.

Questions: *We invite our readers to send us questions, preferably on technical problems that have arisen in actual practice. Questions which we consider of sufficient interest to our readers will either be replied to under "Answers to Correspondents" or replies will be invited from our readers. One shilling will be paid for the question which we select for competitive replies in this column.*

Answers: *A fee of 10s. will be paid for the answer which we consider shows the greatest merit, and 5s. for the one we select as second best. In judging the replies, importance will be attached to clearness and conciseness, as well as accuracy. The Editor reserves the right to make no award, or to accept only one reply, if, in his opinion, the answers received do not possess sufficient merit. Competitors desiring the return of their manuscripts, if unaccepted, should enclose stamped addressed envelope.*

Write on one side of the paper only, and if diagrams are sent, draw them on a separate sheet of paper attached to the manuscript. Competitors may adopt a "nom de plume," but, both in the case of questions and answers, the competitor's real name and address must be sent with the manuscript as a guarantee of good faith. No correspondence will be entered into with regard to successful replies. The Editor's decision is final.

Commencing with Question No. 101, a Diploma of Merit will be awarded to the six competitors who win the first or second prize the most times during the next twelve months.

The words "Questions and Answers" or "Q" and "A" should be placed at the top left-hand corner of all letters intended for this column.

Question No. 169.

I wish to make a resistance to reduce a pressure of 200 volts to 25 volts. I would appreciate details of size of wire, method of mounting coils, etc. The maximum current I wish to take from it is 15 amperes.—J. R. Woodhatch.

Question No. 170.

I desire to make a testing board suitable for testing motors, elements, etc. The supply is 200 volts. Can any reader tell me what instruments and apparatus I shall require, and method of mounting?—J. R. Woodhatch.

(Replies to Questions Nos. 169 and 170 must be received not later than October 27, 1923.)

The Strowger P.A.X. at the New London County Hall.

The recently completed 650-line inter-departmental telephone exchange at the new London County Hall is the largest private Strowger automatic exchange in Great Britain. Besides affording accurate and essentially private inter-communication between the departments in the building, it gives access, through an associated manual telephone switchboard, to the public telephone exchange system and the many outlying districts and local borough administrations which come under the jurisdiction of the L.C.C.

The equipment was manufactured and installed on behalf of the British P.O. Telephone Department by the Automatic Telephone Manufacturing Co., Ltd., of Liverpool.

It operates on what is known as a three-digit basis, i.e., every telephone number within the building consists of three digits, those below 10 being preceded by two, and those below 100 by one nought. Thus Telephone No. 9 would actually be 009, and Telephone No. 89 would be 089, and so on. The act of calling any number on the system thus entails three successive movements of the dial attached to the telephone in use by the calling party. This manipulation by the finger-tip is, however, extremely simple and occupies six seconds only. Assuming the called party to be disengaged, the response is immediate, and in the event of an engaged line a distinctive audible signal is at once heard in the receiver at the calling station. Clearing at the conclusion of a conversation follows the replacement of the receiver upon the switch-hook and is instantaneous, the line, therefore, being immediately available for another call. Further, secrecy is assured, and it is impossible for a third party to interrupt or to listen-in to a conversation already in progress.

For the purpose of obtaining connection with the public exchange an eight-position manual switchboard, equipped with sixty outgoing and fifty incoming junctions, has been installed.

Calls for the outside telephone system are obtained by dialling "O," which causes an individual line lamp at the manual to glow, the automatic switches at the same time being released. The operator answers and completes the call over the outgoing junction in the usual manner.

Calls incoming from the outside telephone system are received at the manual board and are completed by the operator in a multiple of the automatic lines, which is extended to the manual switchboard; the operator thus has direct access to all automatic stations without using the automatic switching equipment.

Night service keys on two of the manual positions provide means for extending thirty of the automatic telephone stations through to public exchanges for

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night service, thus dispensing with the need for night operators at the Council's manual board.

Provision is, of course, made for guarding the lines from intrusion whether they are engaged via the manual or via the automatic board. The equipment is of the latest type with rotary line switches and covered type selector and connector switches.

No separate line intermediate distributing frame is provided, but similar facilities are given by the "unit" type intermediate distributing frame or cross-connecting rack, which is mounted on the top of the individual units.

The power plant for operating the automatics consists of a motor generator set rated for an output of 40 amps. at 60 volts, the motor operating on the 460-volt power supply. There are two 25-cell storage batteries associated with this generating plant, together with small rotary converters for the provision of ringing current.

The example set by the L.C.C. might well be followed by Government Departments and other local authorities.

THE POLYPHASE SYNCHRONOUS INDUCTION MOTOR.

By Wilfred A. Siddans, B.Sc.(Eng.), A.S.P.

The polyphase synchronous induction motor has been developed recently to combine the desirable running feature of the polyphase synchronous motor with the desirable starting feature of the polyphase induction motor. The former is not naturally self-starting, but runs at a constant speed (synchronous speed), whereas the latter is naturally self-starting but has a drooping speed characteristic similar to that of a D.C. shunt motor, the drop in speed on full load being about 5 per cent. for small motors and about 2½ per cent. for large motors, the highest speed (no load speed) being below synchronous speed. Both polyphase synchronous and induction motors have exactly similar stators, although their rotors are not alike. Hence the polyphase synchronous induction motor has such a stator, and by using a suitably wound rotor and a special change-over switch it can be run as a polyphase induction motor for starting up and as a polyphase synchronous motor for working.

In both cases there is a distributed three-phase stator winding giving a three-phase multi-polar alternating magnetic field, the backward travelling components of whose phases neutralise one another at all instants, whilst their forward travelling components are in phase at all instants. Thus there is a travelling wave of magnetism going around the stator at synchronous speed, i.e., 360 electrical degrees per period. In the case of the polyphase induction motor this travelling wave of magnetism moves with a forward speed relative to the rotor according to the amount of slip, and thus induces currents in the rotor winding, which is short-circuited. The torque whereby the rotor is driven is set up by the inter-action of the rotor and stator fluxes, as in the well-known classical experiment made by Arago with a copper disc and a bar magnet. As the load increases (or decreases) and necessitates an increase (or decrease) in the torque, the rotor rotates at a lower (or higher) speed, thereby increasing (or decreasing) the amount of slip, the induced rotor current and its flux, and the torque. In the case of the polyphase synchronous motor the rotor winding carries a direct exciting current fed to it from a D.C. supply or from a direct coupled exciter through brushes and slip rings. Thus, owing to the arrangement of the rotor winding, the rotor has poles of fixed polarity and of the same angular pole pitch as those of the stator and travelling wave of magnetism. The torque, whereby the rotor is driven, is set up by the tangential components of the attractions between unlike poles of the rotor and travelling wave of magnetism. As the load increases (or decreases) and necessitates an increase (or decrease) in the torque, the poles of the rotor lag a little more (or less) behind the poles of the stator and so increase (or decrease) the tangential components of the attractions and the torque at constant speed, which is of necessity synchronous speed. In the case of the polyphase synchronous induction motor the rotor winding has to be arranged to serve both as that of a polyphase induction motor and as that of a polyphase synchronous motor in turn. As will be seen later, it is in arranging for this that a difficulty presents itself.

The motor is started up as a polyphase induction motor by means of a three-phase star connected starter resistance, and is run up to as high a speed as possible as such. Then a change-over switch in the rotor circuit is operated, thus disconnecting the starter resistance and connecting the D.C. supply or the exciter in its stead. The rotor is thus changed from that of a polyphase induction motor to that of a polyphase synchronous motor, and the motor tends to run as a polyphase synchronous motor. But even if the motor has been started up on no load, the speed at change-over will be below synchronous speed. Hence the motor may fail to pull into step at change-over unless change-over has been carried out at just the right instant, viz., when the poles of the rotor are opposite unlike poles of the travelling wave of magnetism of the stator.

If the motor pulls into step it runs quietly at constant (synchronous) speed as a polyphase synchronous motor. But if the motor fails to pull into step, the actual torque is due partly to the synchronous motor torque which, owing to the slip, will be an alternating torque, as shown by curve *A*, Fig. 1, and which will, therefore,

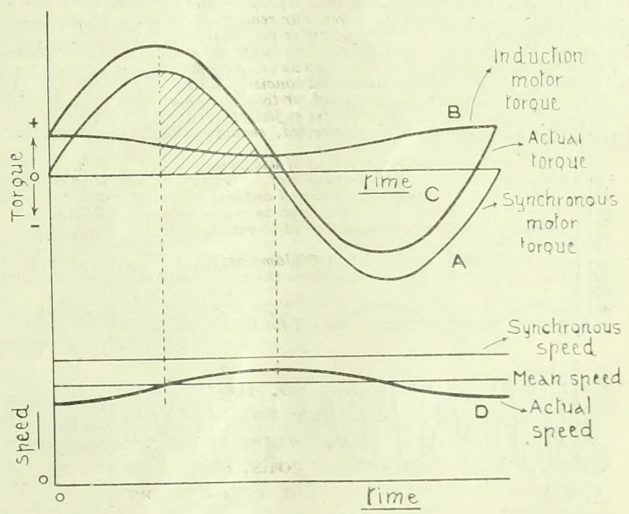


FIG. 1.

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cause the speed to fluctuate, and partly to the induction motor torque which, owing to the slip, will still exist and which, owing to the fluctuating speed caused by the synchronous motor torque, will be a fluctuating torque, as shown by curve *B*, Fig. 1. Under such conditions the motor runs noisily. The actual torque is therefore as shown by the curve *C*, Fig. 1, whilst the actual speed is as shown by curve *D*, Fig. 1, fluctuating about a mean speed below synchronous speed. The alternating synchronous motor torque is similar to the alternating torque due to the backward travelling component of a single-phase synchronous motor, but whereas the frequency of the latter is twice stator frequency, the frequency of the former is only rotor frequency. Note that the induction motor torque decreases as the actual speed increases, i.e., as the absolute slip decreases, and increases as the actual speed decreases, i.e., as the absolute slip increases. The reason the motor fails to pull into step under such conditions is because when the synchronous motor torque is a maximum the actual speed is the mean speed and accelerating. Consequently the energy available for accelerating the rotor is only that represented by the shaded area under half of the positive half of the synchronous motor torque curve instead of that represented by the whole area under the positive half of the synchronous motor torque curve. Hence the maximum actual speed, which occurs when the synchronous motor torque is zero and changing from positive to negative, is below synchronous speed, and the actual speed never gets as high as synchronous speed because, when the maximum actual speed is reached, the synchronous motor torque is zero and changing from positive to negative. Consequently the actual speed fluctuates about a mean speed below synchronous speed. The rotor winding, therefore, carries both the direct exciting current from the exciter and the induced alternating current due to the relative motion between the rotor winding and the travelling wave of magnetism of the stator, and this state of affairs obtains as long as the motor runs out of step. Hence the actual rotor current fluctuates between values equal to the sum and difference of the value of the direct current and the maximum value of the alternating current. Again, when the rotor is accelerating, i.e., when the synchronous motor torque is positive, the machine motors; but when the rotor is decelerating, i.e.,, when the synchronous motor torque is negative, the machine generates as a polyphase alternator, because the rotor is being driven by its excess energy above mean kinetic energy, and this mechanical energy of the rotor is converted into electrical energy in the stator winding. Thus, whereas the magnitude of the back E.M.F. would be constant and of frequency equal to stator frequency if the motor were running in step as a polyphase synchronous motor, the magnitude of the back E.M.F. is alternating and of a slightly fluctuating frequency a little below stator frequency. This changes the wave form of the stator current. Now, as already mentioned, the actual rotor (i.e., exciting) current fluctuates between certain values, hence let the actual rotor current wave be as shown by curve *A*, Fig. 2, this being the resultant of the direct exciting current (curve *B*, Fig. 2) and the induced alternating current (curve *C*, Fig. 2). Then, since the induced alternating current is due to transformer action between the stator (as primary) and rotor (as secondary), the actual stator current will be as shown by curve *D*, Fig. 2, its maximum values occurring when the maximum values of the induced alternating current occur.

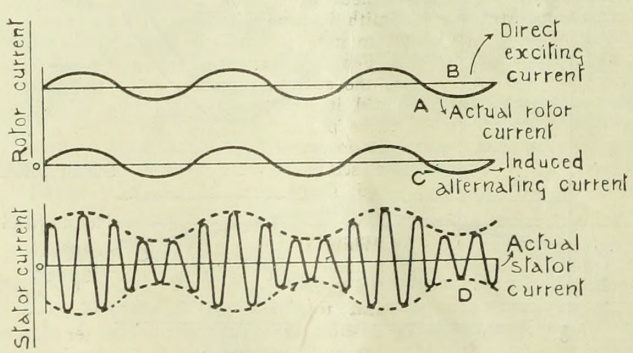


FIG. 2.

(To be continued.)

Reviews of Books, &c.

[Books noticed in this column will be sent from ELECTRICITY *Office to any part of the world, for the published price, plus five per cent. for postage (minimum 2d.), and orders will be appreciated.]*

SUCCESSFUL WIRELESS RECEPTION. By Paul D. Tyers. (P. Marshall and Co., 1s. 6d. net.)—There are very many amateurs who possess wireless apparatus and are far from successful in its operation. Mr. Tyers' book is written for such, and by applying the information the book contains, their reception should be very considerably improved.

Part 2 of the book will appeal to those amateurs having some reasonable knowledge of wireless apparatus, as it deals with experimental valve receiving gear, the troubles found with such apparatus, and gives hints as to the finding and correcting of such troubles.

The table showing the number of valves necessary to obtain signals of a given strength is something new, and shows clearly the approximate distance one can cover, as well as the strength of the received signal for a given set.

The author lays stress on the testing of the aerial and earth system, and shows simple means for making such tests. This is new information to most amateurs, and is valuable.

In common with many other books on wireless, the author does not show in his diagrams the by-pass condensers, which are in most sets so necessary to their proper functioning. The condensers we refer to are those usually placed in shunt with the first low-frequency transformer, or with the head telephones, or high-tension battery, and no stress is given on the value of such condensers or their selection.

The book is to be recommended to wireless amateurs, as it contains much sound and common-sense advice.

WIRELESS FACTS AND FIGURES. By A. V. Ballhatchet. (P. Marshall and Co., 6d. net.)—This little book is, at its price, better value than any book on the subject we have so far seen, and to the amateur with the newly-acquired Constructors' Licence it will provide a fund of information of considerable use.

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The tables of wave-lengths for given diameters of coils and turns are alone worth the cost of the book, and the other various tables are extremely useful. The weights of ebonite sheet given, however, are rather on the light side.

The information relating to various components is condensed and concise, and we most heartily endorse the author's advice on the purchase of low-frequency transformers rather than their construction at home.

Anyone who is considering wireless receiving set building will do well to purchase the book.

RADIO AND HIGH-FREQUENCY CURRENTS. By E. T. Larner. (Lockwood, 3s. 6d. net.)—In the preface of the book the author states that an endeavour is made as far as possible to furnish an introduction to the subject in an elementary way, and although elementary, the book is not intended for the beginner who knows nothing of electricity and mathematics.

In this sense, the opening chapters, at any rate, cover the general idea of the work, but after dealing with such subjects as "Range of Transmission," "Radiation Resistance," etc., the simple descriptions of the thermionic tube and the diagrams of crystal receiving circuits seem rather out of place.

The illustrating plates have little reference to the text, and are not of the kind one would expect to find in a book essentially of a theoretical character.

It is a little difficult to appreciate the value of the book to amateurs, and it certainly has no appeal to the professional.

We have no fault to find with the information the book contains, and the author's ability and grip of his subject is beyond question, but we cannot get rid of the idea that the book was hurriedly compiled, and the inversion of one of the main diagrams in it rather confirms this idea.

Various Items.

"**Irish Engineering**."—This is the title of a new illustrated monthly journal which has just been started in Dublin. It is a well printed production, and covers all the leading branches of the industry. We hope, therefore, that it will have a long and successful career, and that it will increase the engineering trade of the Irish nation, in which there is no doubt ample scope for very important developments.

Awards.—The Council of the Institution of Civil Engineers have made various awards in respect of selected engineering papers published without discussion during the Session 1922-1923 including a Telford Premium to Mr. J. W. Meares, C.I.E., M.Inst.C.E., M.I.E.E. (Guildford), as well as in respect of papers read before meetings of students of the Institution in London and the provinces during the same period.

Accountancy.—Many electrical engineers are included in the large number of good business men who, however, are not well-up in modern accountancy—some knowledge of which is, of course, really necessary for thorough success in life. Readers interested should write to the School of Accountancy, 10, Essex Street, Strand, W.C.2, for the School's Prospectus. The School also has branches in Glasgow, Manchester, Leeds, Liverpool and Birmingham.

Manchester Wireless Society.—At the meeting on Friday, October 12, Dr. Stanley Hodgson gave his second elementary lecture on Electricity as applied to Wireless, and some very interesting experiments were shown illustrating the earlier methods of measuring electricity. A very clear explanation of the behaviour of electrons in conductors and non-conductors gave the members the impression that no such things as solids existed. The next lecture is on Friday, October 26.

Engineering Tuition by Correspondence.—University Engineering College, London, are able to show many appreciative letters received during the present year from their students who have been successful in various examinations: C and G., B.Sc., A.M.I.E.E., A.M.Inst.C.E., etc. The address for application for particulars is Secretary's Dept., University Engineering College, Westgate-on-Sea, Kent.

Meetings.—The Junior Inst. of Engineers will meet at 39, Victoria Street, Westminster, S.W.1, on Friday, 26th inst. Lecturette, "Crystals for Wirless Reception," by A. V. Ballhatchet (member). Slides and exhibits. Also on Friday, 2nd Nov. Lecturette, "Hydraulic Propulsion," by D. V. Hotchkiss (slides). And on Friday, 9th Nov. Lecturette, "Amateur Cinematography," by Dr. C. E. K. Mees (slides). All at 7.30 p.m.——The Inst. of Production Eng. will meet at the Engineers' Club, Coventry Street, London, W.1, at 7.30 p.m., on Wednesday, 31st, when Mr. Arthur Easthope (Petters, Ltd., Yeovil) will deliver a paper on "Idle Capital in the Machinery Shop." Advance copies of the paper may be obtained beforehand from the Hon. Sec., at 6, St. James's Square, London, W.11, and all interested are invited to attend whether members of the Institution or not.

Reduction of B.B.C. Tariff.—Members of the National Association of Radio Manufacturers are prepared to credit their trade customers with the difference between the old B.B.C. tariff and the scale now in force in respect of sets in stock on October 1, 1923, to which B.B.C. tariff applies. Trade buyers desiring to claim credit must lodge the claim with the respective suppliers of the sets on or before November 10, 1923, after which date no further claims will be entertained; each claim must be accompanied by a certificate that the sets were actually in stock on October 1, 1923. Trade buyers should apply to their suppliers for the necessary forms of claim.

Trade with Canada.—We have received No. 1 of the *British Quarterly Bulletin*, which is a paper published with the direct object of increasing the wholesale trade between Canadian importers and British manufacturers. With the next issue the name is to be changed to *British Trade*, and as the normal subscription price is only 4s. per annum, it is to be hoped that it will meet with ready support in this country. There is no doubt that British goods should be better advertised in Canada in order to meet United States competition, and it is to be hoped that this policy will receive strong support in the industrial centres of Great Britain. The publishing office is at 8, University Avenue, Toronto.

Transmission at 220,000 Volts.—The Southern California Edison Co., who have in operation one of the largest hydro-electric stations in America, have now a 200 miles transmission line at 220,000 volts, which is the highest voltage line in the world. Power is generated at 6,600 volts and stepped up by auto-transformers to 220,000 volts at the station on the San Joaquin River, and transmitted to the company's territory south of San Diego. One and a half million horse-power is now used in California (where the population is between 3½ and 4 million), and it is calculated that within 20 years Southern California alone will take 3½ million horse-power. The present duplicate transmission lines are of 1 sq. in. section aluminium. The switching stations are in the open.

Manchester Electro-Harmonic Society.—The fifth season will begin on the 26th inst. with a concert in the Albion Hotel, Piccadilly, at 7.30 p.m. S. L. Pearce, Esq., C.B.E. (Chief E.E., Manchester), is the president, and will preside at this concert on the above-mentioned date, when a large attendance is expected. Mr. W. J. Smith is again hon. musical director. Visiting friends are asked to note the following dates:—Nov. 23, Dec. 21 (1923), Jan. 18, Feb. 15, March 21 (1924); no ticket is necessary for admission, the ordinary professional qualification being sufficient. Should it be possible to give advance information of intention to be present on any particular occasion, communications may be forwarded to either of the following: Mr. W. Kirkham (hon. sec.), 47, Peter Street; Mr. C. E. Leak (assistant hon. sec.), 196, Deansgate, Manchester.

Plant Wanted.—The N.S.W. Govt. Rys. and Trys. invite tenders for transformers for White Bay Power House.——Also for the supply of transformers for the Meek's Road sub-station.——The Municipal Council of Johannesburg invite tenders for the supply of transformers; and for one test transformer.——The State Electricity Commission of Victoria invites tenders for the supply of transformers and spares. Specifications, etc., at the D.O.T. (Room 52), 35, Old Queen Street, London, S.W.1

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Trade Notes.

In order to celebrate their removal to the fine new works at Slough, the **St Helens Cable and Rubber Co., Ltd.**, have issued a new catalogue of their specialities, in which special prominence is given to the progress of their well-known C.T.S. system for house wiring purposes, as well as to their complete range of corrosion-proof fittings. It is excellently printed and bound, while the thumb-indexing renders it easy of reference. There are also certain tables of wire gauges which will come in handy. The book will appeal to every installation contractor. A branch office at 30, Wood Street, Manchester, is now open, where large stocks of C.T.S. and V.I.R. cables are carried as well as all solid band tyres and everlastic tubes. This branch is for the convenience of the company's Lancashire and Yorkshire customers, who have hitherto been used to prompt service direct from the late Warrington works.

Mr. F. Charles Raphael, M.I.E.E., consulting electrical engineer, informs us that, owing to a printer's error in the new Telephone Directory, his address is given as No. 9, Ludgate Hill, instead of No. 19, Ludgate Hill. He asks us to state that his address is St. Paul's Chambers, 19, Ludgate Hill, E.C.4 (Telephone: Central 3387).

The London Factors and Agents, Ltd., of 38-39, Parliament Street, London, S.W.1, whose new list has just recently been issued, direct attention to a unique feature of their trade policy. Their own, standard-quality accessories, cables, conduits and conduit fittings list, is most comprehensive, and they have arrangements that enable them to supply most of the leading manufacturers' specialities at the usual trade prices. Further, as they specialise in catering for small country trade buyers, they are always prepared to obtain for them special outside material, and include it in their cases, thus keeping carriage charges down to a minimum. Their policy is to supply reliable material at the keenest current prices, and they claim that their steadily increasing business proves that they fill a long felt want for the country engineer who cannot always be in touch with the best markets.

Pamphlet No. P. 179, "Pole Line Materials," has just been issued by the **British Insulated and Helsby Cables, Ltd.**, of Prescot. It is a well printed and illustrated catalogue of 40 pp., and covers very thoroughly the whole ground in regard to the requirements for pole lines constructed to suit the varied climates in which the installations may be carried out. There is also considerable interesting technical data in regard to size of line wires, spans and stresses, wind pressure and the swing of lines under wind pressure, bending moment for round fir poles, and, in fact, quite a large amount of information of direct value to the engineer who may have the supervision of the plant during construction or its maintenance during use.

Bastian and Allen (58, Haymarket, S.W.1) have just issued a new catalogue illustrating various new patterns of electric fires and radiators which they are marketing under the trade marks "Rex" and "Quartzalite." Naturally also particulars are included of Bastian Geysers, which are made in all sizes to take a low constant current and give a supply of scalding hot water from 5 to 5,000 gallons per day. A supplementary heater is provided in some cases to augment the output of hot water when necessary. A folder on this subject is also included in the firm's publications.

In the issue of the *Business World* recently received we note that in addition to illustrations and notes on various British Empire Ports and Cities there is a description of the very extensive business of acid and chemical manufacture and merchandising carried on by **F. W. Berk and Co., Ltd.**, whose head office is at 1, Fenchurch Avenue, E.C.3, and whose works are at Stratford and Morriston, near Swansea. Among their many well-known products are B.A.A. accumulator acid, and sulphuric, nitric, dipping, hydrochloric, hydrofluoric acids, etc.

We have received from the **Metropolitan-Vickers Electrical Co., Ltd.** (Trafford Park, Manchester), leaflets numbered 39/1-1, 59/4-1, 59/5-1 and Circular 1059/1. The first is a description of M-V "Standard Squirrel Cage Induction Motors," the second and third of two types of "Auto-transformer" and "Star-Delta Starters," while the Circular describes a simple type of "Automatic Oil-Break Ironclad Switchgear," the basis of which is the starter described in the last-named leaflet. It is fully protected and is designed for small and medium capacities in industrial works.

In addition to the lighting, heating and wireless accessories, batteries, etc., listed in the October Monthly Trade Price List from **Siemens and English Electric Lamp Co., Ltd.** (38-9, Upper Thames St., E.C.4), there is a special offer for the month of various lighting fittings.

Leaflets issued by **A. H. Hunt, Ltd.** (Tunstall Road, Croydon), deal with genuine Hellesen H.T. dry batteries for wireless and L.T. cells for valve filament lighting. These cells give a prolonged heavy current discharge.

A new season's list of electric fires issued by the **Sun Electrical Co., Ltd.** (118-120, Charing Cross Road, W.C.2), deals with Sunco fires and a selection of fires made by some of the leading manufacturers—Belling, Cosmos, Jackson, Heatrae, Premier, Polar Cub, Flamingo. Another leaflet refers to "Presto" ironclad switch and switch-fuse gear, and the "Apex" reversible type fuse switch.

The "Safety First" ironclad control gear for D.C. Motors, developed and manufactured by **Brookhirst Switchgear, Ltd** (Chester), is exhaustively dealt with in their new catalogue, No. 5. Its 72 pp include a detailed specification of the complete range, and also, in the case of each individual combination, an abridged specification, prices and dimensions. In connection with the automatic panels there is also a series of "application diagrams" illustrating the diversity of arrangements possible with automatic control gear. A large amount of post-war development work is recorded

The autumn list of books published by **Messrs. Pitman and Sons, Ltd.**, of Parker Street, London, W.C.2, has just come to hand. It contains particulars of numerous technical and electrical works which are likely to interest readers of ELECTRICITY, and we would therefore suggest that they should all write promptly to Messrs. Pitman asking for a copy. It is well worth careful perusal.

From **George Ellison** (Perry Bar, Birmingham) we received recently a very detailed technical list (No. 66) on T.E. non-automatic air-cooled rotor starters for slip-ring induction motors.

Marconi type "U" combined telegraph and telephone transmitters, made of non-hydroscopic materials so that they are particularly suitable for use at sea and in hot climates, are very fully described and illustrated in Pamphlet No. 217 issued by **Marconi's Wireless Telegraph Co., Ltd.** (Marconi House, Strand, W.C.2). In particular the 1.5 kw. sets are specially dealt with.

The **Cambridge and Paul Instrument Co., Ltd.**, of 45, Grosvenor Place, S.W.1, are issuing a trade card descriptive of the Cambridge Thermionic Voltmeter, and asking readers if they know what it will do. A fully descriptive list will be sent free on application.

No. 1, Vol. I., of "The Osram Bulletin" is the first issue of a monthly trade organ to be published by the **G.E. Co., Ltd.**, for the information and assistance of that large and ever-growing body of dealers who are interested in the sale of electric lamps and lighting accessories generally. It is a well-printed production, with good technical articles descriptive of Osram lamp manufacture as well as of the applications of the lamps to various styles of lighting, including one on Lyons' new Corner House Restaurant, from the pen of our old friend, Mr. A. Wardle Robinson, who is now the publicity manager of the great Cadby Hall organisation. We have no doubt the issues will be welcomed regularly by the huge G.E.C. clientèle.

Meetings.—The next monthly meeting of the Birmingham and District Electric Club will be held on Friday, 26th inst., at the Grand Hotel, at 7 p.m. Paper, "Electric Motors in Service," by Mr. Henry Joseph.

Scholarships.—The following I.E.E. Scholarships have been awarded for 1923-24:—A Salomons Scholarship (value £50) to Mr. James Linton (Heriot Watt College, Edinburgh); David Hughes Scholarships (value £50 each) to Mr. R. MacWhirter (Royal Technical College, Glasgow) and to Mr. R. E. Banks (The University, Birmingham).

Enterprise.—Messrs. Higgs Bros., the well-known motor makers, of Sand Pits, Birmingham, have purchased 14 acres of land at Witton, and have already started the erection of a new works. The first building will be approximately equal in area to the present works, and has been designed with the express purpose of economically manufacturing electric motors up to 50 h.p. They hope to have the first portion completed in about 12 months' time, and will then transfer the whole works to Witton. Hearty congratulations to "Higlets" on their remarkable development. They have certainly earned it.

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A POPULAR SCIENTIFIC WEEKLY JOURNAL
ELECTRICITY
A PRACTICAL TRADE JOURNAL

NOVEMBER 2, 1923.

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RADIO-FREQUENCY AMPLIFICATION.*

By A. Chenik.

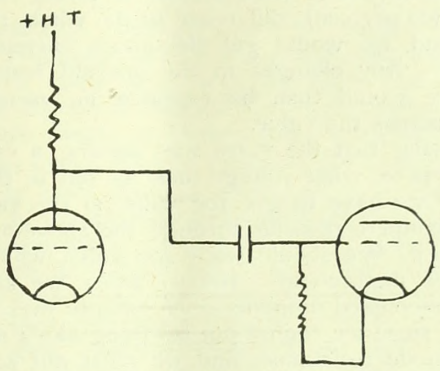
(*Concluded from page* 574.)

If we use a plain inductance coil we will find that we will get potential variations set up across it whatever the frequency of the currents passed through the inductance may be, provided, nevertheless, that the inductance possesses at least a certain minimum value which will increase with the wave-length of the signals being amplified. If now we replace the inductance by a tuned oscillation circuit we will find that if this circuit is tuned to a wave-length differing from that of the incoming oscillations, the potential variations across the anode circuit will be negligible. As we bring the tuning of the oscillation circuit closer to that of the incoming oscillations, the potential variations across the anode oscillation circuit will increase in strength and will reach a maximum when the anode oscillation circuit is exactly tuned to the incoming wave-length.

With every change in wave-length there is a corresponding change in its radio-frequency component, and the shortest wave-length in practical use to-day bears a frequency relation to the longest wave-lengths of about one hundred to one. Due to this wide frequency range, which it is necessary to amplify in order that radio-frequency amplication may be applied to any wave-length emanating from any radio station which may be operating, one method of inter-valve coupling may be found more satisfactory than another. These may be broadly divided into three classes, viz. :

1. Resistance-capacity,
2. Tuned-anode,
3. Transformer.

Fig. 1 shows the principle of this method, which is effected by inserting in the plate circuit of the amplifying valve a resistance of 50,000 to 100,000 ohms, the plate of the valve being connected to the grid of the next valve by a small fixed condenser of about .0002 mfds. shunted by a leak of 1 to 3 megohms, according to the type of valve in use. This method offers a cheap and fairly satisfactory means of amplifying the high-frequency oscillations, especially as it is aperiodic, that is to say, it requires no tuning condenser for the various wave-lengths. It possesses, however, the inherent drawback of decreasing the amplification strength on wave-lengths below about 1,000 metres, owing to the inter-electrode capacity of the valve itself, and the stray capacities which must exist between the different points in the circuit, which act as a shunt to the high-frequency oscillations. Any capacity across the anode resistance will shunt off the high-frequency currents from that resistance and will prevent their being passed on to the next grid. The H.T. battery should not have any appreciable resistance, but it is usually advantageous to shunt it with a condenser of one or two microfarads, so that the high-frequency impulses will go through the condenser rather than through the battery.



1.—Resistance-Capacity.

Let us see how this anode resistance functions in the circuit. If we apply a voltage to the grid of the first valve, and if its anode is connected to the H.T. battery with no resistance in series, when the grid is made positive, the internal resistance of the valve will be lowered and a large anode current will flow, but the anode potential is held constant by the battery, and there is no point in the anode circuit where we can find an amplified change of voltage. In order to operate the second valve we need to so arrange the first that it will amplify the voltages applied to its grid so that these amplified voltages can be applied to the grid of the next valve. We can obtain the desired result by keeping the anode current constant, then, whether we make the first grid positive or negative, we shall get the corresponding changes in internal resistance of the valve repeated in the voltage changes across the terminals of the valve. Although the valve has a characteristic which is not entirely linear, and is therefore often said not to obey Ohm's Law of Current equals Voltage divided by Resistance, this law applies rigorously for any given point on the characteristic, and the anode current is dependent upon the total resistance of the anode circuit, since the applied voltage from the H.T. battery is constant. The anode circuit resistance is made up partly by the valve and partly by the resistance of the outside circuit. If the internal resistance of the valve at any instant is Ra the voltage across the valve will be anode current Ia multiplied by this resistance. Now, if we can put in the circuit

* Paper read before the S.A. Inst. of Electrical Engineers.

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anything to keep the current practically constant, any change in Ra, the effective resistance of the valve (such as may be caused by changes in the grid potential applied to the valve) will be repeated in the voltage across the valve and will be applied to the grid of the next valve by means of the coupling condenser.

Supposing we want to keep this anode current steady, how can we do it? If we make the total resistance in the circuit constant, the current will remain constant. But here we have a constant supply voltage and a variable resistance, so that we cannot actually maintain the current quite constant, but we can get somewhere near it. If we make the remaining resistance in the circuit very large compared with the resistance of the valve, we can keep the current nearly constant. For example, if the valve has an internal resistance of 40,000 ohms, and we put in series with it 4,000,000 ohms, the total resistance would be 4,040,000 ohms. If, then, this 40,000 ohms became 30,000 or 20,000 or even 60,000, it would make only one or two per cent. difference to the whole resistance value, and we would get the anode current almost constant. Any changes in the internal resistance of the valve would then be repeated as variations of voltage across the valve.

Supposing that the valve was passing a current of 1 milliampere, what voltage must be put in the anode circuit if we have to get 100 volts on the valve with one milliampere passing through the above-mentioned resistance? We should want 400 volts, which would be rather unpractical. Hence, when we are using resistance-coupled amplifiers, we have to make a compromise, since we cannot put anything like 4 megohms in the anode resistance, and we must put something of the order of 50,000 to 100,000 ohms so as to limit the total voltage which must be put into the anode circuit in order to get the necessary current through it. Then, when we change the grid voltage, we shall get a change in the anode voltage, but it will not be as big as if there were a large series resistance present. It is, therefore, not possible to hand on a voltage change to the next valve without introducing some loss in amplication, or, in other words, the voltage amplification actually obtained is less than it theoretically would be were the anode current maintained constant, by the voltage that is dropped by the current change through the series resistance.

The great advantage of the resistance-capacity coupling is that there is no part of the intervalve coupling that varies with the frequency (other than stray capacities), so that the amplifier is suitable for use on most frequencies, except when the stray capacities become troublesome, on the shorter wave-lengths which are of much higher frequencies. By fitting up an amplifier of this kind and connecting a variable condenser across the anode resistance, it is easily possible to demonstrate this loss of amplification due to the shunting off from the anode resistance of the high-frequency amplified current changes. With very short wave-lengths, the loss due to the condenser becomes more and more important, because the current which it draws off from the resistance is proportional to the frequency. Hence there are, it will be seen, some practical disadvantages in the resistance-capacity coupling, and on that account attention has been given to obtaining some other coupling method. At the shorter wave-lengths in practical work some method is required to eliminate the difficulty referred to above. What we want is a method which will make the valve capacity and other stray capacities useful rather than harmful. We can do this if we make the capacity either tune or help to tune a circuit. This cannot obviously be done with a resistance in the anode circuit, but if a coil is used instead of a resistance the circuit can be tuned.

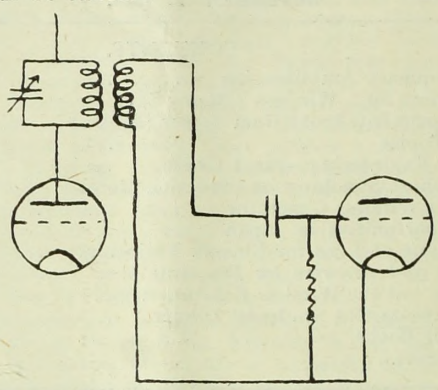


FIG. 2.—HIGH-FREQUENCY TRANSFORMER.

In Fig. 2 will be noted the essentials of this mode of intervalve coupling, where the primary coil of the transformer is connected in the anode circuit of the amplifying valve and the secondary coil is connected across the grid and filament of the next valve. Consider here the effect of the valve capacity, which will behave as a condenser across the transformer winding. Obviously we obtain a tunable circuit, and therefore there will be maximum voltage across the transformer winding for one particular frequency. The effective resistance of the circuit is represented by R^1 equals L/CR, R being the resistance of the coil, L its inductance, and C being the capacity of the condenser. This indicates that the higher the ratio of the inductance to the capacity the bigger is the effective resistance of the whole circuit, and, if the ratio is small, the effective resistance of the whole circuit becomes smaller. Hence, if we use a good inductance, i.e., a coil of low resistance, and tune it by the valve capacity, or by the valve capacity plus a small variable condenser placed in parallel, we get an arrangement which, at a certain frequency, offers a very high resistance to the flow of alternating current through it, although to the D.C. high-tension battery current it offers very little resistance. We can, therefore, in this way keep the steady voltage on the anode of the valve at its normal value, almost identical with the voltage of the battery, whereas at the particular wave-length to which the circuit is tuned, the effective resistance becomes very large, and, therefore, the changes in current flowing through the circuit become very small, and, consequently a maximum alternating (H.F.) voltage is built up across the coil. Further, under these conditions, if there is a maximum of voltage across the primary of the transformer there will likewise be a maximum of voltage across the secondary winding, since in all ordinary transformers of this type the coupling between the two windings is a close one. On account of the method of winding, these transformers act very little as true transformers. They are called transformers and are wound as transformers, but they do not behave as

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transformers. To obtain true transformer action, the two coils must be well separated out so that it is possible to tune the secondary as well as the primary, and in this way to build up in the secondary much higher voltages than could be obtained without such tuning. Thus, by making this intervalve coupling like an ordinary loose coupler with primary and secondary circuits both tuned, obviously we shall build up in the secondary circuit, when using a very small capacity, a maximum voltage, and thus get large voltage amplification between the two stages of the amplifier. When the two coils are wound in the usual commercial manner, the windings are so tightly coupled that they act as one circuit, and tuning one circuit tunes both. It does not matter much whether you tune only one circuit or tune both circuits simultaneously to get the desired wave-length, the result is the same. Thus, when building up a H.F. intervalve coupling transformer, it is not possible to tune up one of the circuits, or to adjust one of the circuits to the desired wave-length until the second winding is in place and joined up. For instance, with a transformer of this type adjusted to give maximum amplification on 600 metres, it will be found that the wave-length of the primary circuit alone, even when connected to the valve and other capacities, will be only 150 to 200 metres before the secondary winding is put on. Therefore, an amplifier of this type must always be adjusted when the transformers, etc., are connected properly in circuit. Now, when a H.F. transformer is designed to work with a tuning condenser across the primary winding, the two windings are wound close together, and the effect of a condenser with capacity C across the primary is to introduce an apparent capacity of

$$C \times \frac{1}{t^2}$$ (where t^2 is the step-up ratio of the transformer)

across the secondary winding. As the valve and accidental capacities across the secondary winding are added to the apparent capacity transferred from the primary, the turn ratio can only slightly exceed unity. As the ratio of the transformer is limited to the secondary possessing the same number of turns, or, in any case, only a few per cent. more turns than the primary, the great advantage of using a transformer has gone. The object of a transformer is to match impedances. For best efficiency, and to straighten out the characteristic curve of the valve to minimise possible distortion, the primary of the transformer is given a high impedance to secure the maximum amplification, and, theoretically, the secondary should be wound so that the greatest voltage step-up takes place, or, in other words, as the in-put impedance of the second valve is of the order of a megohm, the impedance of the secondary of the H.F. transformer should be of the same order. This, obviously, cannot be done, and the transformer has practically a turn ratio of one to one. Now, what happens is that there is so much capacity between winding and winding that the potential across the primary is transferred to the next grid by capacity, and very imperfect capacity at that. Why not substitute a properly insulated condenser for the relatively poorly insulated capacity between the windings? On account of the close coupling between them, the two windings behave as one coil, and, although some of the energy is handed on to the next valve by ordinary transformer action, a considerable portion of the whole available energy is handed on by the electrostatic capacity between the two windings. In this case, therefore, we can obtain similar results by using one winding only and tuning it by means of a small condenser, with the result that we would get a maximum voltage built up across the coil when it is in tune with the working frequency. We then have only one circuit, one coil to tune, and we can build up across it a voltage which is the maximum it is possible to obtain, being limited only by the amplification factor of the valve and the resistance of the coil winding. This, then, is a further step in the evolution of a simple high-frequency amplifier, and brings us to the third method of H.F. intervalve coupling.

(To be continued.)

ACCUMULATORS FOR "WIRELESS," MOTOR-CARS, ETC.

Accumulator batteries specially designed for the various requirements of wireless equipments occupy an important place in a new catalogue issued by the Chloride Electrical Storage Co., Ltd., whose extensive works are situate at Clifton Juntion, Manchester.

Besides the standard "Exide" battery, type 3-CZ5-1, for fairly slow rates of discharge, *e.g.*, for filament heating of thermionic valves, each battery consisting of the requisite number of cells cemented together and supplied with hard-wood containers, if desired, there is a series (type 3-AZ3-1) similar to foregoing, but with more robust plates and thicker celluloid boxes. For H.T. "grid" batteries there is the B.K. Exide set. This is ingeniously constructed of test-tubes, in which are suspended miniature plates, see Fig. 1. These

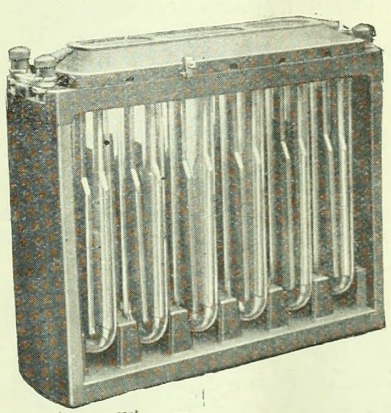


FIG. 1.

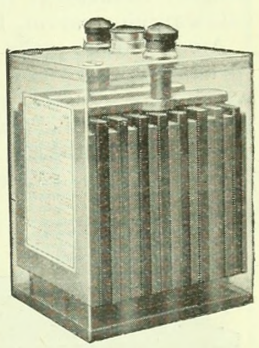


FIG. 2.

plates are true Exide plates, and are as carefully made and spaced as the larger ones, and each cell can be quickly and thoroughly inspected at any time. The test-tubes are supported in a moulded composition container, which, together with the lid, is acid proof. A higher capacity accumulator for similar service is also made. This is type AYG1. For use where very long slow discharges are necessary, as with "dull emitter" valves, there is the new H.Z. type battery, Fig. 2, which need only be recharged every six months, unless the full capacity has been taken out in a shorter period. It is listed in three capacities, 40, 60 and 80 amp.-hours

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actual intermittent. The following testimonial to the Company's London office is of interest :—

Taroba, Dorney Reach,
Taplow, Bucks.
October 10, 1923.

The Chloride Electrical Storage Co., Ltd.,
219-229, Shaftesbury Avenue, W.C.2.

Dear Sirs,—With reference to the HZ.4 type 40 ampere-hour accumulator which I had from you some time ago, you will be interested to learn of its operating capabilities with two Marconi DER valves.

This accumulator was charged on August 10 and continued in service until September 28, being used practically every day. The total discharge, as you will see by the attached sheet,* has been 110 hours at .8 amps. I could have discharged still further, for its recuperating qualities seem to be extraordinary. I can detect no noises whatever from this cell while in use . . . . .

The discharge is perfectly steady and no "frothing" has been experienced. I have, previous to this last charge, gone out of my way to give the cell abnormal conditions of discharge, and by leaving it for long periods in a discharged condition, but so far I have been unable to trace any signs of sulphating or of the plates disintegrating.

I certainly think that this type of accumulator is ideal for DER valves, owing to its recuperative properties and to the fact that it should be able to stand long periods of low discharge without having any deleterious effect on the plates.

Yours faithfully,
(Signed) J. MALIN.

Another important branch of the company's small battery business is concerned with starting, lighting and ignition batteries for automobiles. These batteries are made in a large number of patterns and include designs for the Austin-Twenty, Morris-Oxford, Morris-Cowley cars, etc., as well as for motor-cycles. The general robustness of design can be seen from the cutaway illustration, Fig. 3, which shows the type XC.

Among other cells listed are those for "service" handlamps and the patent unspillable accumulator, which was adopted by the Ministry of Munitions and used extensively a few years ago.

In Fig. 4 is seen a specially designed cell for operating such appliances as electric bells and clocks. This cell is supplied in a "dry-charged" condition and needs only the addition of electrolyte to render it ready for service, and unless fully discharged in a shorter period, need not be recharged more frequently than once in every six months. Miniature Exide accumulators for working models, etc., are also among batteries listed in this catalogue (section P).

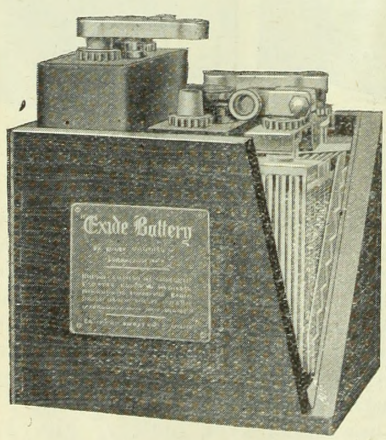


FIG. 3.

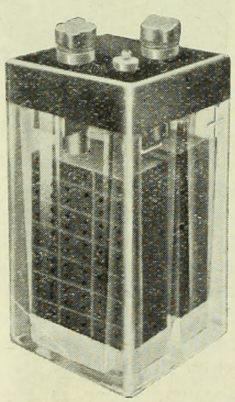


FIG. 4

* Too long to be reproduced.—Editor.

OVER 700 PER CENT. PROFIT FROM BETTER LIGHTING.

Tests recently conducted in a number of American workshops, factories, etc., show in striking manner what a handsome return is derived from the small investment required to provide good artificial lighting. Average figures can, of course, give only an approximate indication of the results which may be achieved by providing better illumination in industrial establishments, but, when nine series of tests in plants of very different classes show an average increase in production of 15.5 per cent.—when the average foot-candles of illumination is raised from 2.3 to 11.2 foot-candles—it is evident that tangible results may be expected from improved lighting. Further, when it is found that the average cost of the additional lighting in these installations was only 1.9 per cent. of the pay-roll, it is evident that the better lighting is giving an average return of 15.5—1.9 × 100/1.9 = 720 per cent. in the shape of extra production! By spending 1.9 per cent. more in wages with the old standard of illumination, we could presumably obtain 1.9 per cent. increase in output, but by spending this extra amount on improved lighting we get 15½ per cent. increase in output. Good lighting undoubtedly pays; and of the several forms of good lighting, electric lighting is undoubtedly best.

Naturally, these average figures do not indicate the best results that can be obtained from improved lighting. Thus, from the results of the individual tests as reported in the *Journal* of the American I.E.E., it appears that in a pulley finishing shop where the average lighting was improved from 0.2 to 4.8 foot-candles, at a cost equal to 5 per cent. on the wage bill, the increase in production was no less than 35 per cent.! Again, in a shop where piston rings are made, the lighting was raised from 1.2 to 18.0 foot-candles at a cost equal to only 2 per cent. on the wage bill, and the production was thereby increased 25.8 per cent.

A test which gave less spectacular, but, perhaps, even more convincing results, was carried out in the U.S. Post Office Department. In an office where letter sorting was formerly done under an illumination of 3.6 foot-candles—which one might reasonably think adequate—the output was increased 4½ per cent. by raising the illumination to 8 foot-candles, the cost of this improvement being equal to 0.6 per cent. of the wages bill. Clearly he will be a rash (or a foolish) man who assumes that the lighting of his office or workshop cannot profitably be improved. Increased output at such small cost means an appreciable cheapening of production, and hence better chances of successful competition, quite apart from the greater comfort and safety of working under better illumination.

Mid-Lancashire Electricity District.—The Electricity Commissioners have made an Order under Section 7 of the Electricity (Supply) Act, 1919, giving effect to the approved scheme, and it has been submitted to the Minister of Transport for confirmation.

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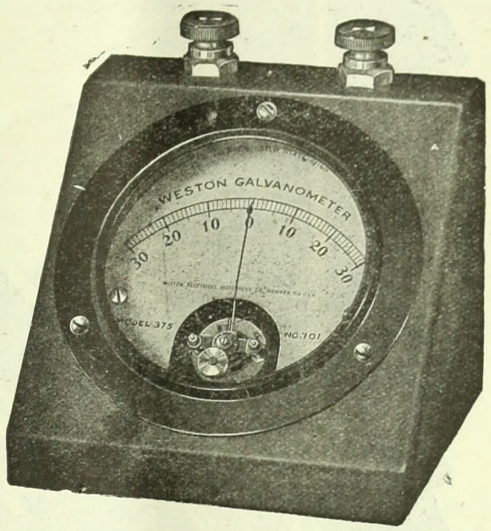
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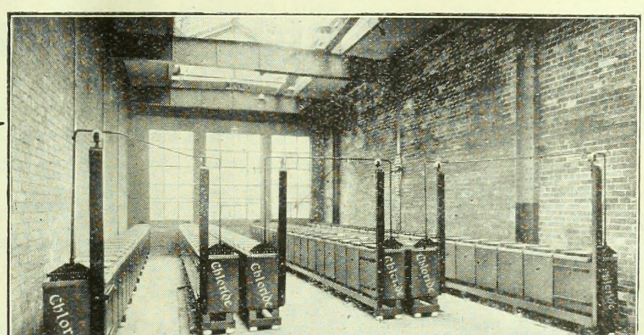


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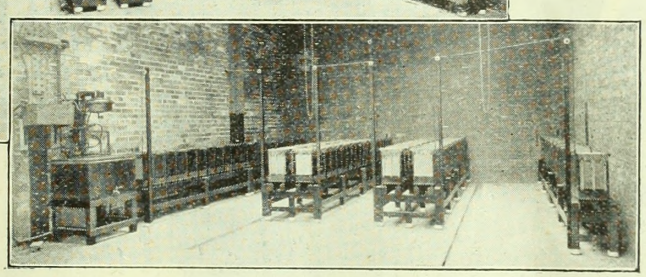
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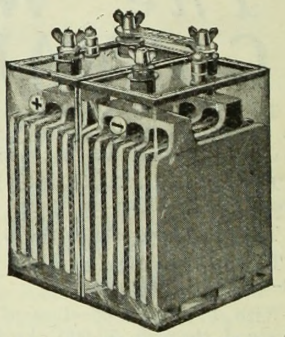
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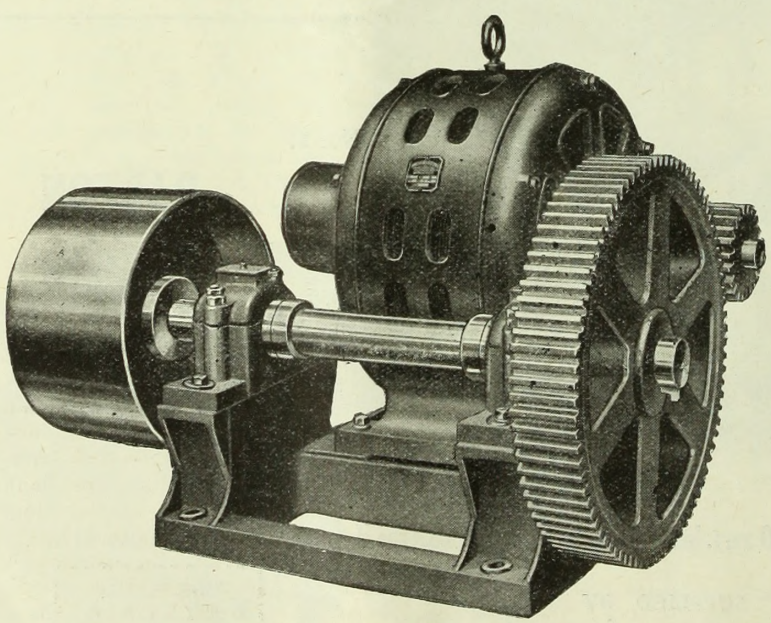


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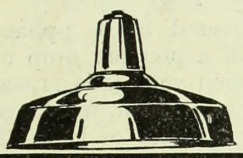
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Current Topics.

Coming Events, etc.

The advent of automatic telephones in London is foreshadowed by the introduction of new four-digit numbers to all new subscribers in the areas likely to be first affected. Thus, new exchanges, such as that at Golders Green, which will probably be opened early next year, will have a range of numbers from 1,000 to 9,999, enabling the Strowger Automatic Telephone system to be introduced at short notice. In some instances this change of telephone number will involve additional digits to those constituting existing numbers, the reason for the change being that certain minimum movements of the calling dial on the automatic telephone are necessary to actuate the mechanism at the exchanges, and it is essential to secure these minimum movements from every subscriber, no matter whether his original number be 1 or 10,000. To this end the existing three-digit numbers will probably have a nought added as an affix. Thus No. 399 would become 0399, whilst two-digit numbers would have two noughts in front, No. 66 becoming 0066, and so on.

However inconvenient the change in existing telephone numbers, as affecting stationery, etc., it should be welcomed by everybody concerned as heralding the fact that the Post Office at last really means business, and that it has acquired the "automatic sense" which the telephoning public have been trying to instil into it for the last ten years. London will soon enjoy the same telephonic advantages as Leeds, Portsmouth, Blackburn, Paisley, Epsom, and a few other provincial places which were introduced to the Strowger system some years ago, and have long since appreciated the many benefits it confers. The efficient automatic telephoning of the metropolis is rather more complex; but, nevertheless, quite within practical Strowger politics, and with the introduction of "four-figure" numbers we appreciate that the thin edge of the wedge has been inserted, and that "Now we shan't be long."

"Reduced" Tramway Fares.

In view of the imminent municipal elections, the Liverpool Tramways Committee recently instructed their tramways manager to reduce the existing high fares to a maximum of 2d. for the full journey on any route, as well as readjust intermediate stages. They made a proviso, however, that there must be no loss on the undertaking as a consequence of the change. To avoid an imaginary loss, the manager immediately carried out his instructions, but eliminated overlapping stages, so that, in effect, the much-talked-of "Reductions" actually figured in many instances as increases on the existing fares for short-distance travellers. Naturally, there was a storm of opposition, and people who had been paying a penny for certain fixed stages raised their voices in protest when asked to fork out twice the amount under the Corporation's "reduced fare" scheme.

In deference to public opinion, the fares have since been readjusted on a more equitable basis, and the tramways manager protects himself by the general statement that he estimates a loss on the half-year's working of £81,520 in consequence. Concurrent with this statement it was announced at a recent meeting of the Liverpool City Council that since the last reduction in tramway fares the number of passengers carried had largely increased. In view of this we take it that the increased number of passengers has been carried in the *same* number of cars as previously. In other words, there has been still more vicious overcrowding. That this evil is being aggravated is evident from the fact that when a new route is opened to serve newly-developed Corporation housing estates, the number of cars in service on the old route which debouches into the new at a given point in the suburbs is reduced, to the extent of the number ear-marked for the new route.

Thus the new district is served at the expense of an already overcrowded existing one, and by a still further addition to the practice of strap-hanging. In considering the finances of their tramways undertaking, the Liverpool City Council apparently overlook or deliberately ignore the very large annual loss they sustain through the inability of the tram-conductors to collect the whole of the fares in an overcrowded car. In effect, vicious overcrowding simply means that a large percentage of the public are being carried free, not because they deliberately refrain from tendering the legal fare, but because in the crowded state of the vehicle, both inside and out, it is a physical impossibility for one man to get round in the time and even obtain the necessary access to his passengers to collect the money and issue tickets in exchange. That I am not exaggerating in this connection, I can vouch from personal experience in that city. When last in Liverpool I saw two shillingsworth of unpaid fares alight, in sheer desperation at the end of a short stage, because the guard was unable to take their money. This must involve a loss of thousands of pounds in the course of twelve months, money which

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would be far more profitably expended in increasing the available rolling-stock to cope with the demand for transport.

Too Much "Talkee-Talkee."

Some resentment is being shown in the Brighton district over the procrastination of the Southern Railway in getting on with the job of main-line electrification between London and Brighton. In the course of an interview, for which the Brighton Corporation had pressed, the general manager of the railway stated that reorganisation arrangements render it impossible at the present time to consider the question of electrifying the main line referred to. In response to this disappointing pronouncement the Corporation urged very rightly that the economies in working expenditure alone would, according to the company's figures, yield a substantial percentage of the capital expenditure involved, without regard to the very great development of traffic which would undoubtedly result therefrom. It was also pointed out that the Government is prepared to offer all possible facilities and financial assistance to schemes of this nature which are accelerated in order to find work for the unemployed.

Discussing the question of electrification, Alderman Carden, of Brighton, said the scheme was apparently complete in every detail, and published in the technical Press two years ago. "It will bring Brighton within forty minutes of London," he added, "and make Brighton a real suburb of the metropolis, and certainly the most popular—a suburb, in fact, without the suburban atmosphere. Unemployment in the country is now so acute that nothing short of comprehensive schemes of this nature being forthwith put in hand will relieve the situation."

My sympathies are with the Brighton Corporation, and, incidentally, the unemployed likely to be affected by the commencement of this much talked-of conversion. On the face of it, there is far too much "hot air" over these projected big schemes and too little action as a result. "Deeds, not Words" should be the the motto of all big railway or other industrial managements. In the short space of two years and eight months the iniquitous "dole" system has cost the taxpayers of this country no less a sum than £128,000,000, for, in fact, fostering idleness and inefficiency. Any sane business man would have spared no effort to formulate productive schemes of employment on the large scale long before this, and provided honest work for a large percentage of those dole recipients who are every day becoming more unemployable. Somehow or other we seem to lack sufficient strong men in industry, men with the courage of their convictions, and who can get things moving. We are developing, industrially, a policy of eternal—"Wait and see."

ELEKTRON.

I.E.E., Western Centre.—Provisional arrangements for meetings have been made as follows:—November 5, 1923, Bristol, Professor David Robertson will give an address on "The Mariners' Compass"; December 3, Swansea; January 7, 1924, Cardiff; February 4, Bristol; March 3, Swansea; April 7, in Devon, probably Plymouth or Torquay; May 3, Forest of Dean, Speech House. The papers have not yet been definitely settled. Also, there will probably be an extra meeting in Cardiff in January to meet the President, if this can be arranged.

ELECTRICAL ENGINEERING—FINAL GRADE.

SOLUTIONS TO 1923 EXAMINATION QUESTIONS OF THE CITY AND GUILDS INSTITUTE.

BY EDWARD HUGHES, B.Sc. (Eng.), A.M.I.E.E.

(*Continued from page* 580.)

Q. 9.—What load can be delivered by a 3-phase overhead line five miles long with a pressure drop of 10 per cent.? Given that the station voltage is 11,000 volts, resistance per mile of each line 0.09 ohm, reactance per mile 0.08 ohm, and the power factor of load 0.8 lagging.

A. 9.—Voltage drop between transmitting and receiving stations

$$= \frac{10}{100} \times 11{,}000 = 1{,}100 \text{ volts.}$$

$$\therefore \text{Voltage drop in each line} = \frac{1{,}100}{1.73} = 635 \text{ volts.}$$

Total resistance of one line $= 5 \times 0.09 = 0.45$ ohm.
Total reactance of one line $= 5 \times 0.08 = 0.40$ ohm.

$$\therefore \text{Total impedance of one line} = \sqrt{(.45)^2 + (.4)^2} = 0.602 \text{ ohm.}$$

If I be the current line,
then $I \times 0.602 = 635$
$\therefore I = 1{,}055$ amps.

In order to calculate the power delivered at the receiving station, it is necessary to determine the voltage at that point. Let $O\,I$ in Fig. 14 represent the line current.

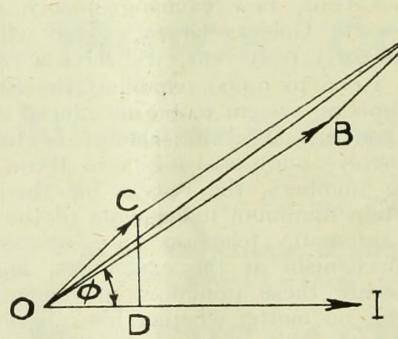


FIG. 14.

For convenience, suppose the windings at each end to be star-connected, then—

$O\,B$ = phase voltage at receiving end, leading $\phi°$ in front of $O\,I$, cos ϕ being the power-factor of the load
$O\,D$ = voltage drop per line due to resistance
$D\,C$ = voltage drop per line due to reactance
$O\,C$ = resultant of $O\,D$ and $D\,C$
= voltage drop per line due to impedance
= 635 volts
$O\,A$ = resultant of $O\,B$ and $O\,C$
= phase voltage at transmitting end
$= \frac{11{,}000}{1.73} = 6{,}350$ volts

But cos $\phi = 0.8$.
$\therefore \phi = 36° 52'$.

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Also, $\tan C\,O\,D = \frac{C\,D}{O\,D} = \frac{0.4 \times I}{0.45 \times I} = 0.889$

$\therefore C\hat{O}D = 41^\circ\ 38'.$

But $C\hat{O}\,B = C\hat{O}D - B\,\hat{O}I.$
$= 41^\circ\ 38' - 36^\circ\ 52'.$
$= 4^\circ\ 46',$

$\therefore \cos C\,O\,B = 0.9965.$

From the parallelogram law we have—

$O\,A^2 = O\,B^2 + O\,C^2 + 2\ O\,B \cdot O\,C \cdot \cos C\,\hat{O}\,B$

i.e., $(6350)^2 = O\,B^2 + (635)^2 + 2 \times 635 \times 0.9965 \times O\,B$

$\therefore \quad 40.35 \times 10^6 = O\,B^2 + 0.4035 \times 10^6 + 1266 \times OB$

$\therefore \quad (O\,B + 633)^2 = 40.35 \times 10^6 - 0.4035 \times 10^6 + (633)^2$
$= 40.35 \times 10^6$

$\therefore\ O\,B = 6350 - 633 = 5717$ volts.

$\therefore$ Line voltage at receiving end $= 5717 \times 1.73$
$= 9890$ volts.

$\therefore$ Load delivered at receiving end $= 1.73 \times 1055 \times 9890 \times 0.8$ watts
$= 14{,}450$ kw.

(To be continued.)

THE POLYPHASE SYNCHRONOUS INDUCTION MOTOR.

By Wilfred A. Siddans, B.Sc.(Eng.), A.S.P.

(Concluded from page 582.)

The best instant for changing over is the instant that the synchronous motor torque is zero and changing from negative to positive. In this case the energy available for accelerating the rotor is that represented by the whole area under the positive half of the synchronous motor torque curve. Hence the maximum actual speed, which occurs when the synchronous motor torque is zero and changing from positive to negative, is more nearly up to synchronous speed, and the motor will probably pull into step without oscillating. If the actual torque is not quite sufficient to do this, it will at any rate raise the mean speed so that the motor will pull into step during the second or third cycle. The variations in the rotor and stator currents in this case are shown by the curves in Fig. 3. Before

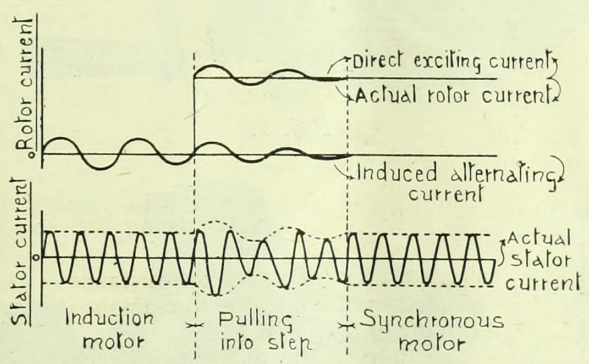


FIG. 3.

change-over the rotor current will be the induced alternating current at rotor frequency, whilst the stator current will be an alternating current at stator frequency. The latter will be small if the motor is on no load. At change-over the rotor current will momentarily be the resultant of the direct exciting current from the exciter and the induced alternating current due to the slip, whilst the stator current will fluctuate due to the transformer action. After change-over, when the motor has pulled into step, there will be no slip and hence no induced alternating current in the rotor winding. Consequently the rotor current will be the direct exciting current, whilst the stator current will be an alternating current at stator frequency. The latter will be small if the motor is on no load.

Polyphase synchronous induction motors run best at unity power factor, and, since they have cylindrical wound rotors, they develop a very large starting torque, just like polyphase induction motors, which they are, for starting up. If a large amount of power factor correstion would be required and a very large starting torque is not essential, it would be better to use a polyphase synchronous motor having a salient pole type of rotor. This could be run up to speed by means of a small polyphase induction motor having two poles less than the polyphase synchronous motor, and synchronised in the usual way. The simplest arrangement of change-over switch gear for a polyphase synchronous induction motor is as shown in Fig. 4. When the switch arm

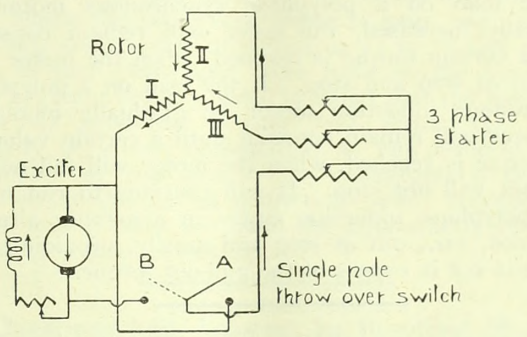


FIG. 4.

is at *A* the motor is a polyphase induction motor and can be started and run up to speed as such by means of the three-phase starter. At change-over the switch arm is put over to *B*, when the motor becomes a polyphase synchronous motor excited by the exciter. The main disadvantage of this arrangement is that, when the motor is running as a polyphase synchronous motor, the phases of the rotor winding do not all carry equal currents. As may be seen from the arrows which show the directions of the direct exciting currents, phases II and III carry half each, whilst phase I carries the whole. Another disadvantage of this arrangement is that the three-phase starter is always in the rotor circuit. This, however, can be overcome by using a three-pole throw-over switch, as shown in Fig. 5. This second arrangement, however, still has

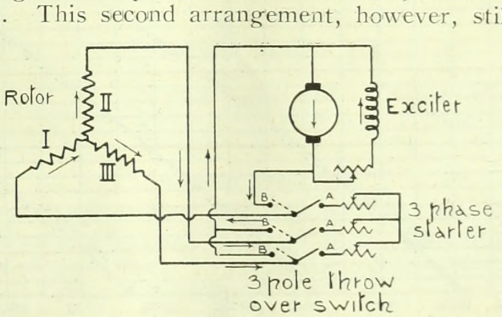


FIG. 5.

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the main disadvantage that the direct exciting current is distributed unequally in the rotor winding. The Oerlikon Co. overcame this by dividing into two halves in parallel that phase of the rotor winding which has to carry the whole of the direct exciting current (see Fig. 6). They also do away with the change-over switch gear by leaving the exciter permanently in the rotor circuit, so that the motor pulls itself into step automatically when run up to speed.

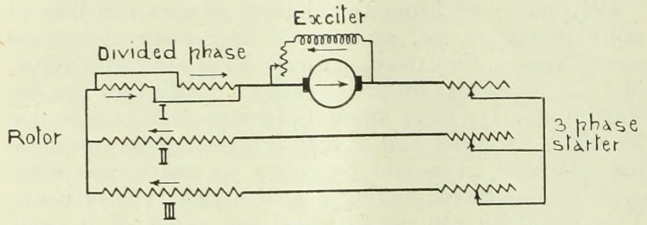


FIG. 6.

The polyphase synchronous induction motor might be regarded as merely a method of starting up polyphase synchronous motors, but it is more than that. If the load on a polyphase synchronous motor be gradually increased, the speed will remain constant until a certain torque is reached, when the motor will fall out of step and stop. If the load on a polyphase synchronous induction motor be gradually increased the speed will remain constant until a certain value of the torque is reached, when the motor will fall out of step but will not stop. It will continue to run more as a polyphase induction motor in a manner already explained, viz., out of step and noisily, providing the torque is not in excess of the pull-out torque.

EVERSHED'S WIRELESS GENERATOR.

It is not surprising that the makers of the "Megger" testing sets should have turned their attention to the manufacture of a H.T. generator suitable for wireless telegraphic and telephonic transmission circuits, either amateur or commercial.

To obtain a steady terminal E.M.F. it is obviously necessary to control the wave-form of the pressures in the individual armature coils, so that the superimposed waves will give as a resultant a straight line representing the terminal pressure. To obtain absolute perfection in this direction is not humanly possible in a commercial generator, but a remarkably close approximation to a straight line (see actual output curves shown in Fig. 1) has been obtained by extending the armature beyond the pole-pieces, thus making use of the stray field, which was found to influence the wave-form in the desired direction, and by specially shaping the pole-pieces for the same reason.

It is difficult to go into the theory of these modifications, as they were made as the result of experimental work. A Joubert ring was used to investigate the pressure at a large number of points in the cycle covered by one revolution of the armature and for plotting the voltage curves.

The four-ring commutator, as used in the "Megger" generators, gives smooth commutation with low frictional and electrical resistance, and is therefore retained. A condenser is embodied in the terminal block on the generator, and is shunted across the terminals.

It is not claimed that the delicate instrument will not indicate any trace of ripple, but actually the superimposed currents from the armature coils gives a steady uni-directional current, quite suitable for wireless transmission, and with properly designed transmitting apparatus smoothing devices may be dispensed with.

Two types of generator have been standardised, differing only in the method of driving. In the hand-driven unit (Fig. 2) a spur gear reduction with a ratio of 27 to 1 is interposed between the driving handle and the spindle, with a ratchet gear to prevent rotation in the wrong direction. The ratchet drive also serves another useful purpose in that it allows the armature to over-run the handle if this is suddenly slowed down or stopped, thus preventing damage to the machine. The belt-driven type (Fig. 3) may be run by a small motor, one-tenth or one-eighth h.p. being ample, connected up to a house lighting circuit.

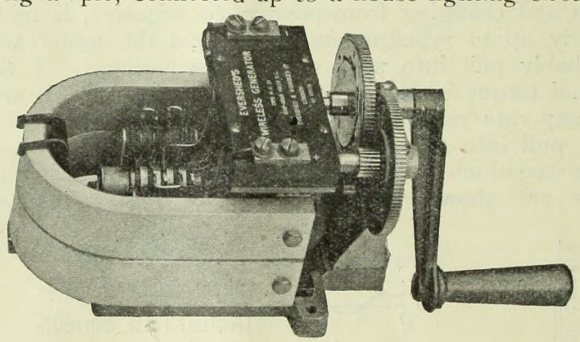


FIG. 2.

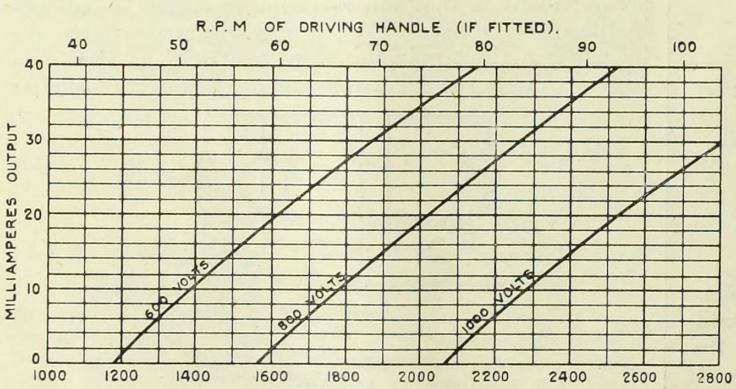


FIG. 1.

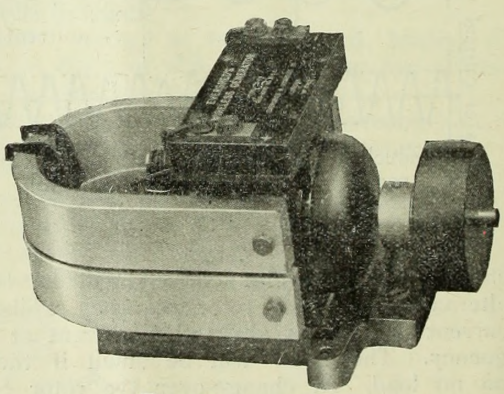


FIG. 3.

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Both types of generator are built to give outputs of the order indicated on the curves shown in Fig. 1. They may, of course, be much more heavily loaded, but overloading, if excessive, is attended by imperfect commutation. It is also necessary to guard against short-circuiting the terminals of the generator.

For further details of these machines readers should apply to Messrs. Evershed and Vignoles, Ltd., Acton Lane Works, Chiswick, W.4.

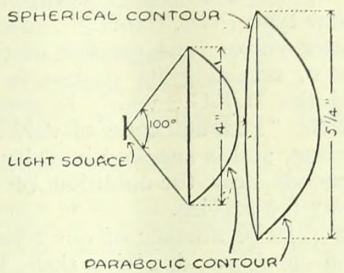
TRADE OPPORTUNITIES IN JAPAN.

The issue of the Board of Trade Journal for the 25th ult. contains a most interesting and instructive special article on the earthquake in Japan, together with a résumé of some economic consequences arising therefrom. Certain portions of the article will appeal directly to the electrical manufacturing undertakings in this country, because there is no doubt that much electrical material and plant will be required in reconstruction work. Apparently a great deal of damage was done to the railways, tramways and telegraphic and telephonic systems. This, therefore, will involve the supply of large quantities of wires and instruments in order to replace what has been destroyed. Rolling-stock also will be needed for the electric tramways, while in the rebuilding of the Port of Yokohama it is certain that cranes and transporters will be required, and it is to be hoped that these will be driven electrically. In another direction, many of the hospitals were destroyed, as well as many of the shops supplying surgical and scientific instruments, so that there is certain to be a demand for violet-ray and X-ray apparatus, as well as for electrical measuring instruments and meters generally. It is to be hoped that the British manufacturers will do their utmost to gain as much business as possible, more particularly in view of the fact that there will be keen competition from America and Belgium, as well as possibly from other Continental countries. With regard to credit, full advantage should be taken of the Trade Facilities Act, and any British companies working in Japan who wish to bring forward schemes which come within this Act are recommended to communicate at once with the Advisory Committee at 16, Finsbury Circus, E.C.2.

A NEW TYPE OF LENS FOR CINEMA PROJECTORS.

For some time it has been known that accurately ground "aspheric" surfaces, *i.e.*, surfaces of other than plane or spherical contour, would make possible much better control and utilisation of light in projection, but early lenses of this design were so costly that they could not be afforded in motion picture condensers. The use of such lenses has, however, become more than ever desirable now that incandescent lamps are employed so extensively for projection purposes, and we learn, from the *Journal* of the American I.E.E., that two-element parabolic condensing lenses, of the dimensions and arrangement shown in the accompanying figure, are now obtainable at a reasonable price. A special holder for the new condenser has been designed for attachment to the lamp housing.

Not only is better control of the light obtained by means of the parabolic curvatures, but also the second lens is larger than the one next the lamp, and utilises light which is entirely lost when two lenses of the same diameter are employed. In the latter case the second lens cannot intercept all the light transmitted by the first.



It is claimed that the new lens gives from 20 to 60 per cent. more light on the screen than is obtainable with an ordinary prismatic condenser, the exact increase depending on the focal length of the objective employed. The new lens will be particularly appreciated where the projection throw is long, say, 100 to 125 feet, and the size of picture is 15 to 18 feet or so. It is in such cases that more light on the screen is most urgently needed, and it is found that the parabolic condenser produces at 125 feet throw the same intensity of screen illumination as has hitherto been obtainable at 100 feet. This constitutes a distinct advance in the art of projection with incandescent lamps and greatly broadens the applicability of such lamps to cinema projection.

Questions and Answers by Practical Men.

RULES.

QUESTIONS : *We invite our readers to send us questions, preferably on technical problems that have arisen in actual practice. Questions which we consider of sufficient interest to our readers will either be replied to under "Answers to Correspondents" or replies will be invited from our readers. One shilling will be paid for the question which we select for competitive replies in this column.*

ANSWERS : *A fee of 10s. will be paid for the answer which we consider shows the greatest merit, and 5s. for the one we select as second best. In judging the replies, importance will be attached to clearness and conciseness, as well as accuracy. The Editor reserves the right to make no award, or to accept only one reply, if, in his opinion, the answers received do not possess sufficient merit. Competitors desiring the return of their manuscripts, if unaccepted, should enclose stamped addressed envelope.*

Write on one side of the paper only, and if diagrams are sent, draw them on a separate sheet of paper attached to the manuscript. Competitors may adopt a "nom de plume," but, both in the case of questions and answers, the competitor's real name and address must be sent with the manuscript as a guarantee of good faith. No correspondence will be entered into with regard to successful replies. The Editor's decision is final.

Commencing with Question No. 101, a Diploma of Merit will be awarded to the six competitors who win the first or second prize the most times during the next twelve months.

The words "Questions and Answers" or "Q" and "A" should be placed at the top left-hand corner of all letters intended for this column.

QUESTION NO. 171.

I have a 10 h.p. motor and the cone insulation on the vee rings has given out. How can I build this up again?—"A. C. WARNER."

QUESTION NO. 172.

Can any reader give working details of the method of producing power by means of motor generators for motion picture work? I require 75 amperes at 75 volts.—"CINEMA OPERATOR."

(Replies to Questions Nos. 171 and 172 must be received not later than December 1, 1923).

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"CHLORIDE" AT THE WIRELESS EXHIBITION.

The Chloride Electrical Storage Co. will occupy Stand No. 7 at the Wireless Exhibition, which is due to be held at the White City from November 8 to 21, where they will exhibit storage batteries of every type, specially designed for radio work, including two interesting new types, viz., the H.Z., specially designed for dull emitter valves, and capable of discharging at very low rates, retaining its charge for at least six months; and the D.T.G., which is specially suitable for use with the "Peanut" type of valve. This latter is in a glass box, and is supplied in a dry-charged condition, and needs only the addition of electrolyte to render it ready for service.

We expect a large number of our readers will visit the exhibition, and would advise them to call at the stall and ask for the pamphlet entitled "How to choose and how to use a wireless battery." It is well worth careful perusal. If you can't get to the White City, write to the company and ask for it.

FARADAY HOUSE OLD STUDENTS' DINNER.

The annual dinner of this association was held at the Hotel Cecil on October 19, Mr. H. W. Miller, M.I.E.E., the president of the association, being in the chair. The president announced that an "Old Faradian" had sent a gift of £25 for the Sports Club of the College. The toast of "Faraday House" was proposed by Mr. W. W. Lackie, C.B.E. He pointed out that he had met Faradians holding leading positions in all parts of the world. He was interested to notice that the College was affiliated with the City of Winnipeg Hydro-Electric System, one of the leading cities of the world in municipal ownership. Four Faraday House students were now there, studying the latest developments in high-tension hydro-electric engineering. In reply, Dr. Alexander Russell reported the continued prosperity of Faraday House. The workshops, laboratories and testing rooms were all being re-equipped with the very latest machines and apparatus. In 1919, the College was affiliated to 71 works, corporation undertakings and electric railways. It is now affiliated to 139, of which 81 are manufacturing works. He reported the successes of the old students during the past year. "The Guests" was proposed by Mr. A. F. Berry, and Sir James Devonshire replied in an amusing speech.

During the evening a presentation of a handsome cabinet of silver and a gold cigarette case was made to Dr. Alexander Russell, to mark his accession to the presidentship of the Institution of Electrical Engineers. The presentation was made by Mr. H. W. Miller in an interesting speech, in which he recalled Dr. Russell's long association with Faraday House, and the esteem and affection in which he was held by Faradians, as witnessed by the fact that 600 of them had subscribed to this presentation. Dr. Russell, in reply, said it was very gratifying to see so many fathers and sons among the Faradians present, and that of the original small class with which they started in 1890 two had sons who had gained the highest entrance scholarship at Faraday House.

Reviews of Books, &c.

[Books noticed in this column will be sent from ELECTRICITY *Office to any part of the world, for the published price, plus five per cent. for postage (minimum 2d.), and orders will be appreciated.]*

THE WORLD-WIDE ATLAS. 11th Edn. (W. and A. K. Johnston, Edinburgh, 15s. net).—An atlas which is clearly printed, well indexed and up to date in regard to political boundaries is an essential in every up-to-date office, more particularly in view of the conditions of trade at the present time and the necessity for working our hardest to recover the ground lost in our exports. We therefore extend a very cordial welcome to the eleventh edition of this well-known work, which contains 112 pages of maps in full colours as well as a copious index. A new scheme of colour printing has been adopted therein, and the result is a book which is certain to give the utmost satisfaction. One point we note with pleasure is that the Empire, as such, takes first consideration, and, instead of ending with Australia and New Zealand, as has hitherto been the case with most of the atlases with which the writer has been acquainted, in this particular instance North and South America come at the end and Australia comes more in the centre. We are confident that it will meet with much appreciation from all who are wise enough to purchase copies, and we can strongly recommend it as a most useful office accessory, quite apart from its value in a scholastic and educational sense.

JOURNAL OF INST. E.E., INDEX TO VOLS. 48 TO 59, 1912-21. Demy 8vo, 184 pp. (Spon, 10s. 6d. net).—We congratulate the secretary of the Institution on the publication of this very comprehensive index. It is certain to prove of great use to all who value their copies of the Journal and have occasion to make reference thereto in the course of their professional duties.

UNIVERSITY COLLEGE (LONDON) CALENDAR, 1923-4. (4s. 6d. post free.)—The six hundred odd pages of this calendar contain voluminous details in regard to the whole work of the college, from the outlines of the foundation onwards. The names of the college officers are given, the various professors, scholarships available, courses of study, fees, and in fact all the hundred-and-one items which ought to be known by those who enter the University and take up the study of any of the faculties for which it offers such splendid opportunities. In electrical engineering, Prof J. A. Fleming, the Vice-Dean, is ably supported by Messrs. W. C. Clinton and C. C. Hawkins, with Mr. A. N. Jackson as assistant and lecturer in design, and they can claim with pride that many of the most prominent and rising men in our great profession have been trained by them.

THE POULSEN ARC GENERATOR. By C. F. Elwell, M.I.E.E., M.A.I.E.E., Fellow of the Institute of Radio Engineers. (Ernest Benn, Ltd., 18s. net.)—Until the publishing of this book, it has been necessary to refer to various articles which have appeared in the technical Press and odd chapters in various wireless books in order to obtain any information on the Poulsen arc

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generator. This volume has been written in order to give a complete idea of its action, and it also constitutes a very complete record of the many forms and arrangements given to the arc generator when designed in different countries and by different engineers.

There is no question that Mr. Elwell must take most credit due to the extensive use and the practical development of this more-than-well-tried means of providing energy for wireless communication over long distances.

It is a most acceptable book, and although the preface states that it is not intended to be a technical treatise, it certainly does give the reader an extremely good insight into the subject from a theoretical, technical and, what is often better still, a practical standpoint.

The very complete bibliography embodied is, in itself, a most valuable work of reference, as it forms what we should imagine to be a complete index of all articles of any importance written upon the subject.

The book is well arranged and printed, and the illustrations are extraordinarily good. There are one or two chapters dealing with auxiliary apparatus and apparatus for signalling, which perhaps do not strictly fall within the title of the work. At the same time, they are important and of interest as components of large arc transmitters.

The information on the Poulsen arc generator as a measuring apparatus gives suggestions for many new uses for this method of generating high-frequency current, and we should like to see in further editions of the book Mr. Elwell's ideas on the maximum and minimum frequency range, and also on the characteristics of the arc in various gases.

The commercial value of the Poulsen arc generator is most strongly emphasised in the appendix, giving a list of the principal radio stations employing such generators, and one cannot but agree with the author in his concluding remarks, when he suggests that the form of generator for wireless work should be viewed from a strictly commercial basis, that is to say, by the established first costs, and inclusive running costs of an installation to handle the contemplated traffic. It certainly does not seem possible at present to put forward a less costly system, so one may predict some years of very useful service for the arc generator, during which period it will no doubt be improved.

To the average experimenter the system is almost an impossible one to handle, and this may account for the general lack of knowledge of the system in wireless circles other than those directly connected with its use.

After reading Mr. Elwell's book one feels that there must be scope for the system on much shorter wavelengths than those to which it has hitherto been applied if used with some type of static frequency multiplier.

As far as the application to radio telephony is concerned, the general methods of modulation of aerial currents that are shown seem to be wrong after reading the effect produced by super-imposing on a 10-ampere direct-current arc as small a current value as .001 amperes, so a future development may produce an arc-controlled arc.

In conclusion, we strongly recommend the book to all readers interested in the commercial development of wireless telegraphy and telephony.

The "Journal of the I.E.E."—We are open to receive offers, on behalf of a client, for the complete numbers of the *Journal of the Institution of Electrical Engineers*, comprising Vols. 38 (1906-7) to 60 (1922) inclusive. Write ELECTRICITY Office, 36, Maiden Lane, Strand, W.C.2.

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Various Items.

Meeting Postponed.—The joint meeting of the Inst. E.E. with the British Section of the Société des Ingénieurs Civils de France, which was to have been held on Thursday, November 15, has been postponed to Thursday, November 22, when a paper by M. Bachellary, entitled "The Electrification of the Midi Railway," will be read and discussed.

Lecture.—Dr. W. Rosenhain, F.R.S., is to lecture before the Inst. of Metals, London Local Section, on "Some Impressions of American Non-Ferrous Metallurgy," on Thursday, November 8. Invitations to the lecture may be obtained by sending a stamped and addressed envelope to the Hon. Sec. of the Local Section, Miss K. E. Bingham, M.Sc., The National Physical Laboratory, Teddington, Middx.

Tenders Accepted.—The tender for nine months' supply of Siemens Electric Lamps, both vacuum and gasfilled types, has been accepted by H.M.O.W.——The tenders of the Siemens and English Electric Lamp Co. have been accepted as follows:—L.M. and S. Railway Co., Siemens gasfilled lamps for the ensuing three months, and Southern Railway Co., Siemens vacuum and gasfilled lamps for the ensuing four months.

Bequest to the Junior Inst. of Engineers.—The Institution has for many years in the past been enabled, through the generosity of the late Mrs. E. O. Durham (wife of Lieut-Colonel F. R. Durham, C.B.E., M.C., M.Inst.C.E., chairman of the Institution from 1907-1909), to offer annually a Bursary of £25 for competition amongst members between the ages of 20 and 23 years. It was Mrs. Durham's desire that this encouragement to the younger members to persevere in their technical and practical studies should be continued after her death, and to effect this bequeathed, by her will, to the Institution a sum sufficient to endow a Bursary in perpetuity.

Meetings.—The Junior Inst. of Engineers will meet on Friday, 2nd inst. Lecturette, "Hydraulic Propulsion," by D. V. Hotchkiss (slides). Also on Friday, 9th inst., lecturette, "Amateur Cinematography," by Dr. C. K. Mees; and on Friday, 16th inst., annual general meeting. All at 7.30 p.m. at 39, Victoria Street, S.W.1. On Saturday, 17th inst., visit to the carriage and repair depot of the Underground Railway at Acton at 2 o'clock.——The Inst. of Heating and Ventilating Engineers will meet at the Engineers' Club, Coventry Street, London, W.1, at 7 p.m., on Wednesday, 7th inst., when a lecture entitled "Some Common Faults in Fan Design and Application" will be given by Mr. F. G. Whipp, A.M.I.Mech.E.

At the next meeting of the Diesel Engine Users' Assocn., which is to be held on Friday, 16th inst., at the I.E.E., a paper on the subject of "Some Considerations Affecting the Choice of a Heavy-oil Engine" will be read by Mr. Geoffrey Porter, A.M.I.C.E. (Past-President). Non-members interested in the subject and desirous of attending the meeting can make application for tickets of admission to Mr. Percy Still, the Hon. Sec., at 19, Cadogan Gardens, London, S.W.3.—— The Wireless Section of the I.E.E. will meet in the Lecture Theatre of the Institution on Wednesday, 7th inst., at 6 p.m., when the inaugural address will be given by the Chairman, Mr. E. H. Shaughnessy, O.B.E.

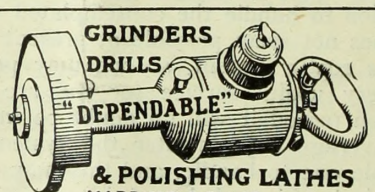
A Valuable Publication.—We have received from the International Railway Congress Association, 17, Rue de Louvain, Brussels, a copy of the *Bulletin* issued monthly by the Association. This *Bulletin*, which is in English, contains a wealth of valuable information, and costs only 3s. 6d., plus postage for a single issue, or £2 per annum, including postage. The October issue contains, *inter alia*, tentative specifications for concrete and reinforced concrete, and a number of important papers dealing with bridge calculations, railway track construction and maintenance, and train control. There are also descriptions of many new appliances for use on railways, and an excellent classified list of books and papers dealing with railway equipment, operation and associated matters.

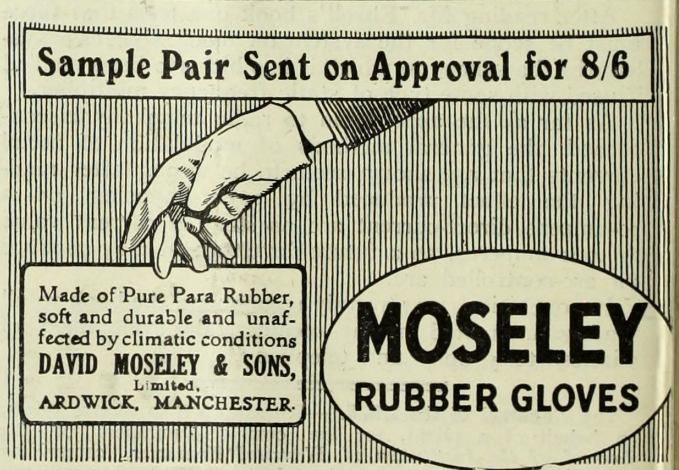
The Motor Show at Olympia.—This year's Exhibition reveals a new Olympia, the enlargement of which has enabled all the exhibits to be housed under one roof, thereby dispensing with the White City section. Over 500 firms are displaying their wares, and the countries represented include Great Britain, France, Italy, America, Belgium and Holland, while prices will largely be found to be even on a lower level than before the war, chiefly due to the result of concentrating on a fewer number of models, and also because prices have been based on a much larger output. Far from stagnation in design, the models reveal progress to an astonishing degree, particularly with regard to the little high-speed engine capable of "revving" up to 4,000 per minute. Not that the slower "revving" engine is falling from favour, many designers still pinning their faith to the type which depends largely upon its cubic capacity for power as against high speed. On the ground floor one sees the finished product; in the gallery you get an idea of the vastness of the industry and learn how the complete cars below are constructed. It is here the motorist learns all about the mechanism of the magneto and how the sparking plug functions, how the starter operates, and how the electricity is generated to furnish the electric lighting, and the science of carburation grasped.

Book Wanted.—Messrs. S. Rentell and Co., Ltd., of 36, Maiden Lane, W.C.2, wish to purchase a clean second-hand copy of *Electric Railway Engineering*, by Parshall and Hobart, which is now out of print. Perhaps one of our readers may have a copy for sale.

Plant Wanted.—The Municipal Council of Sydney invite tenders for transformers.——The Municipal Council of Johannesburg invite tenders for electric cables.——The Municipal Council of the City of Cape Town invites tenders for transformers.——The Auckland Electric Power Board invite tenders for transformers and accessories.——The State Electricity Commission at Melbourne invite tenders for aluminium steel cored cable and accessories.——The State Electric Light Works of Montevideo invite tenders for general stores, including oilcans, cotton waste, lubricating grease and powdered graphite, Para rubber belting, cable, wrenches, insulating compound, and lamp shades.——The P.M.G.'s Dept., Melbourne, invite tenders for the supply of protectors for telephone apparatus (Schedule V 201). Specifications, etc., from D.O.T. (Room 52), 35, Old Queen Street, London, S.W.1.

Personal.—At the last meeting of the Diesel Engine Users' Assocn. the President announced that Mr. Percy Still, who had held the office of Hon. Sec. of the Association since 1914, had felt obliged to ask the Committee to make arrangements to relieve him of his duties after the end of the current year, as he found that the great growth in the work in recent years was taking up too much of his time. The President remarked that when Mr. Still took up the duties of Hon. Sec. over nine years ago there were about 30 members, whereas at the present day the total membership ran into about 400. The Committee had already given the matter their careful consideration, and they were hopeful that before the next meeting they would be in a position to put forward a suggestion under which the work might perhaps be carried out by Joint Hon. Secs. They hoped that under such an arrangement the services of Mr. Still might be retained for the Association, and we are certain that all those who know how Mr. Still has worked on its behalf will also join in that hope.





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A POPULAR SCIENTIFIC WEEKLY JOURNAL
ELECTRICITY
A PRACTICAL TRADE JOURNAL

NOVEMBER 9, 1923.

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PROBLEMS IN TELEPHONY, SOLVED AND UNSOLVED.*

BY PROFESSOR J. A. FLEMING, M.A., D.Sc., F.R.S.

I.—INTRODUCTORY.

(1) In looking back at the titles of previous Kelvin Lectures it is noticeable that one subject, in which the late Lord Kelvin took a profound interest from its earliest days, has not yet received attention in them—viz., that of Telephony or the transmission of articulate speech to a distance by electrical means.

I well remember, as if it were only yesterday, though it is in fact 47 years ago, sitting close in front of Lord Kelvin when as Sir William Thomson he gave the Introductory Address to Section A of the British Association, then meeting in Glasgow, when he described to us his first acquaintance with Bell's great invention, the speaking telephone. Lord Kelvin had just returned from the United States, where he had been one of the scientific judges at the Centennial Exhibition at Philadelphia in June, 1876. Addressing us he said :—

"In the Canadian Department I heard 'To be or not to be, there's the rub,' through a telegraph wire; but scorning monosyllables the electric articulation rose to higher flights and gave me passages taken at random from the New York newspapers, such as 's.s. *Cox* has arrived' (I failed to make out s.s. *Cox*); 'The Senate has resolved to print a thousand extra copies'; 'The Americans in London have resolved to celebrate the coming Fourth of July.' All this my own ears heard spoken with unmistakable distinctness by the thin circular disc armature of just such another little electromagnet as this which I hold in my hand. The words were shouted with a clear, loud voice by my colleague Judge, Professor Watson, at the far end of the telegraph wire, holding his mouth close to a stretched membrane, such as you see before you here, carrying a little piece of soft iron which was made to perform in the neighbourhood of an electromagnet in circuit with the line motions proportional to the sonorific motions of the air. This, the greatest by far of all the marvels of the electric telegraph, is due to a young countryman of our own, Mr. Graham Bell, of Edinburgh and Montreal and Boston, now becoming a naturalised citizen of the United States. Who can but admire the hardihood of invention which has devised such very slight means to realise the mathematical conception that, if electricity is to convey all the delicacies of quality which distinguish articulate speech, the strength of its current must vary continuously and as nearly as may be in simple proportion to the velocity of a particle of air engaged in constituting the sound."

In the year therefore following that of the decease of the illustrious inventor of the speaking telephone it is perhaps appropriate that the Kelvin Lecture should direct attention to some of the problems of telephony which have been solved or which remain unsolved in the nearly half-century which has elapsed since the above quoted words were uttered by Lord Kelvin.

Since the reproduction of articulate speech at a distance necessitates the creation of air waves and this requires the expenditure of energy, it will be convenient to start with a statement of the physical relations of the measurable quantities with which we are concerned, and of the methods by which we can determine the energy expenditure in creating audible and articulate sounds.

II.—SOUND-WAVE ENERGY.

(2) When a sound wave is passing through the air, if the sound is a continuous one, there is at any point in the field a rapidly repeated change of air pressure which periodically rises above or falls below the normal static pressure of the air, as determined by the barometric height at that moment, which is approximately 14½ lb. per square inch, or about 1 megadyne per square centimetre in C.G.S. measure. There is therefore a variable pressure superimposed on a steady pressure, and we may define the conditions by stating the R.M.S. value of the variable part of the pressure in absolute units or by the ratio of the maximum of the variable part to the steady pressure.

In a sound wave we have also periodic variation of air density at any point, and hence another way of defining the acoustic state is by the variation in air density which occurs. If ρ is the normal density of the air and ρ' the increased or reduced density, then the ratio $(\rho' - \rho)/\rho = s$ is called by the late Lord Rayleigh and other writers the *condensation* at that point. The condensation takes place in consequence of a pendulum-like motion of the air particles to and fro in the direction of propagation of the wave. It is usual to consider the maximum condensation during the periodic change. If for the sake of simplicity we confine our attention to propagation in one direction, or consider the case of a parallel beam of sound or propagation through a straight tube, then we can easily obtain an expression for the rate at which energy is being transmitted across each square centimetre of the tube cross-section.

For it is clear that this is equal to the mean value of the product of the air velocity in the direction of the wave, and the variable pressure.

Problems in acoustics are in many cases best treated by the use of a quantity called the *velocity potential*, which is a function of time and space such that its space rate of change in a certain direction gives us the acoustic velocity of the air particles in that direction.

In the case of a plane sine-form wave due to a pure musical sound propagated in the direction of the x-axis, the velocity potential b is expressed by :—

$$b = B \cos (mx - \omega t) \quad . \quad . \quad . \quad . \quad . \quad (1)$$

where $m = 2\pi/\lambda$ and $\omega = 2\pi n$, λ being the wave-

*Lecture delivered before the Institution of Electrical Engineers, to whom we are indebted for the use of the illustrations.

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length and n the frequency of the sound wave. Hence, differentiating (1) with respect to x, we have the velocity of the air particle in that direction.

Let it be denoted by $\dot{a}$ where the dot denotes time rate of change of displacement a. Then

$$\frac{da}{dt} = \dot{a} = \frac{db}{dx} = -mB \sin (mn - \omega t) \quad . \quad (2)$$

Hence the displacement a is obtained by integrating (2) with respect to time, thus :—

$$a = \frac{mB}{\omega} \cos (mx - nt) \quad . \quad . \quad . \quad . \quad (3)$$

Therefore, if A is the maximum displacement or amplitude, $A = mB/\omega = B/c$, where c stands for the velocity of sound. It is shown by the late Lord Rayleigh in his "Treatise of Sound" (vol. 2, § 244, p. 14) that if ρ_0' is the normal density of the air and p the variable part of the pressure, then, in the absence of other impressed forces :—

$$p = -\rho_0 \frac{db}{dt} \quad . \quad . \quad . \quad . \quad . \quad (4)$$

The energy transmitted per second by the wave through 1 square centimetre normal to the line of propagation, is the mean value throughout a period of the product $p\dot{a}$.

Now,
$$\frac{db}{dt} = \omega B \sin (mx - \omega t) \quad . \quad . \quad . \quad (5)$$

Therefore from (2), (4) and (5), and bearing in mind that the mean value of $\sin^2\theta$ throughout a period is $\frac{1}{2}$, we have for this mean rate of transfer of energy :—

$$W = \tfrac{1}{2}\rho m \omega B^2 . \quad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$

If c denotes the velocity of sound, $c = \omega/m$, then, since $A = mB/\omega$, (6) may be written—

$$W = 2\pi^2 \rho_0 c n^2 A^2 \quad . \quad . \quad . \quad . \quad . \quad . \quad (7)$$
$$= \tfrac{1}{2}\rho_0 c \omega^2 A^2$$

The normal density of air is $\rho_0 = 0.00129$ gram/cm^2, and the velocity of sound in air at 0°C. and 760 mm. is $c = 3.3 \times 10^4$ cm/sec. Also, $2\pi^2 = 19.75$ and, therefore,

$$W = 840.75 n^2 A^2 \quad . \quad . \quad . \quad . \quad . \quad . \quad (8)$$

where n is the frequency and A is the maximum displacement of the air particle by the sound wave during its excursion. If we denote the maximum value of the velocity of the air particle by $\dot{A}$, then it is obvious from (5) that $\dot{A} = mB$ and that $\dot{A} = \omega A$.

If we assume that we are dealing only with pure musical sounds having a simple sine wave-form, then the root-mean-square (R.M.S.) value of any variable is $1/\sqrt{2} = 0.7$ of its maximum value. Then from (2), (4) and (5) it is seen that :—

$$(\text{R.M.S.})p = \frac{\rho\omega B}{\sqrt{2}} \quad . \quad . \quad . \quad . \quad . \quad (9)$$

$$(\text{R.M.S.})\dot{a} = \frac{mB}{\sqrt{2}} = \frac{\dot{A}}{\sqrt{2}} \quad . \quad . \quad . \quad (10)$$

The expression (9) is the root-mean-square value of the variable part of the pressure, and (10) the same for the air particle velocity. Also by (6) :—

$$W = (\text{R.M.S.}p)\ (\text{R.M.S.}\dot{a}) \quad . \quad . \quad (11)$$

From the above formulæ it follows that :—

$$(\text{R.M.S.})p = \sqrt{(\rho_0 c)}\ \sqrt{W} \quad . \quad . \quad . \quad (12)$$

$$(\text{R.M.S.})\dot{a} = \frac{\sqrt{W}}{\sqrt{(\rho_0 c)}} \quad . \quad . \quad . \quad . \quad (13)$$

The value of $\rho_0 c$ in C.G.S. units is 42.57, and $\sqrt{(\rho_0 c)} = 6.5$ (nearly).

If the pressure (p) is measured in dynes per square centimetre then the energy (W) transmitted through 1 square centimetre per second is in ergs, and the velocity $\dot{a}$ in cm. per second, then :—

$$(\text{R.M.S.})p = 6.5\sqrt{W} \quad . \quad . \quad . \quad . \quad (14)$$

$$(\text{R.M.S.})\dot{a} = \frac{\sqrt{W}}{6.5} \quad . \quad . \quad . \quad . \quad . \quad (15)$$

and
$$(\text{R.M.S.})p = 188.5 nA \quad . \quad . \quad . \quad (16)$$

If s denotes the *condensation*, defined as above, it is shown in treatises on acoustics that $cs = \dot{a}$, where c is the velocity of sound. Hence, if S is the maximum value of the condensation, $cS = \dot{A} = \omega A$, and also $S = (\omega/c)A$.

The above formulæ give us the means of making interesting deductions from experimental results as to the variation of air pressure and amplitude of motion of the air particles in a sound wave.

In using these formulæ it is necessary to bear in mind that, since the changes of pressure in an air wave are very rapid, the heat due to compression has not time to escape. Hence the pressures are adiabatic values and by the gas theory are equal to γ times the isothermal pressures, where $\gamma = 1.41$ is the ratio of the two specific heats of air. Therefore $p = \gamma s = 1.41 s = \sqrt{(2)}s$ (nearly). Since γ is nearly equal to $\sqrt{2}$ it follows that for pure musical sounds the R.M.S. value of the variable part of the pressure is equal to the maximum value of condensation.

(To be continued.)

ELECTRICAL DEVELOPMENTS IN GUERNSEY.

BY AN ENGINEERING CORRESPONDENT.

The Channel Islands are certainly amongst the most interesting pleasure resorts easily accessible from the British Isles. They have a life and atmosphere of their own—beliefs and customs of very old standing—and the main occupation of growing fruit, flowers and vegetables has doubtless a certain influence on the temperament of the inhabitants. Jersey has two small railways, but in Guernsey there is none, and the absence of trains has been instanced as one explanation of the somewhat leisurely and restful atmosphere.

In one respect, at least, Guernsey is ahead of its sister island. It has an enterprising electric supply company which has faced difficulties in the past but is now consolidating its position and doing well. There is also a gas company, but apparently the two concerns get on quite amicably, most of the interior lighting being electrical, while gas finds its chief field for heating purposes. Street lighting is done almost entirely by gas, but there are special local reasons to account for this.

The electrical supply has always been continuous current, and in its early stages the company was associated with an enterprising but unsuccessful attempt to use high-voltage transmission. At the present time 210 volts for lighting and 420 volts for power are used. The chief asset is undoubtedly the lighting load, though there is quite a considerable amount of power taken by the local granite quarries. To a Londoner most of the shops appear somewhat underlighted, but the conditions in the leading hotels and public buildings are in the main satisfactory. The

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illumination of the Royal Hotel, where the writer stayed, is quite good, and enterprising use is made of small lamps with coloured bulbs (in series) for decorating the gardens at night. The company has a well-designed and equipped showroom, and organised an up-to-date demonstration of domestic applications of electricity at the local exhibition, which took place during my stay. The great part of the load is naturally located in the two main towns of St. Peter Port and St. Sampson's, but there are some feeders carrying electricity to quite remote parts of the island. Guernsey is also to be congratulated on an excellent telephone service, which is stated to be cheaper than that in any other part of the British Isles. There is a single line electric tramway between St. Peter Port and St. Sampson's. This was formerly supplied by the Guernsey Light and Power Co., but it now relies chiefly on a separate station of its own.

Another item of interest to engineers is the enterprising flying-boat service, which reduces the time from Southampton to Guernsey to about an hour and a quarter. During my visit rough weather and poor visibility interfered with the service, but in the summer it should afford an ideal means of getting a bird's-eye view of the islands.

Electrical engineers who visit Guernsey will thus find something to interest them. It need not be said that there is also much of general interest both in Guernsey and its delightful subsidiary islands, Herm, Jethou and Sark. The local industries of fruit and vegetable culture well repay study, and the cliff scenery of Guernsey and Sark is unique. The writer would like to express his appreciation of the hospitality of the Guernsey Chamber of Commerce and of the facilities offered by the Southern and Great Western Railways, who did everything possible for my comfort.

THE ELECTRIFICATION OF A TYNESIDE SHIPBUILDING YARD.

One of the best known names in connection with North-East Coast shipping is that of Messrs. Smiths Dock Co., Ltd., who possess three large repair yards on the River Tyne, one ship repair and one shipbuilding yard on the River Tees. Besides shipbuilders and repairers they are also manufacturers of engines and all types of low-pressure oil-burning plant, forced and natural draught plant, etc. The various yards are equipped with modern machinery, considerable use being made of electricity, both for power and lighting purposes.

A general view of the ship-repairing yard at South Shields, known as the "High Docks Department," is seen in Fig. 1, which also gives a good impression of the shipping activities of the Tyne. Here the original 550-volt D.C. supply has recently given place to a 2,200-volt, 50-cycle, three-phase supply, with earthed neutral from the South Shields Corpn. Electricity Works. Distribution is made from a sub-station, which contains two 500 kw. transformers for power, and one 75 kw. for lighting. The L.T. voltage of the latter is 115. The H.T. side of the transformer is controlled by a steel boiler plate cubical switchboard, conforming to the latest Home Office requirements. The isolating links are operated by a pull rod from the back, the link chamber being interlocked with the oil switch, so that it is impossible to open the door until the oil switch is in the "off" position. A further interlock is arranged to prevent the oil switch from being closed when the link chamber door is open. It is, therefore, impossible to operate the links when the oil switch is in the closed position. An interesting point is that the division plates and through insulators

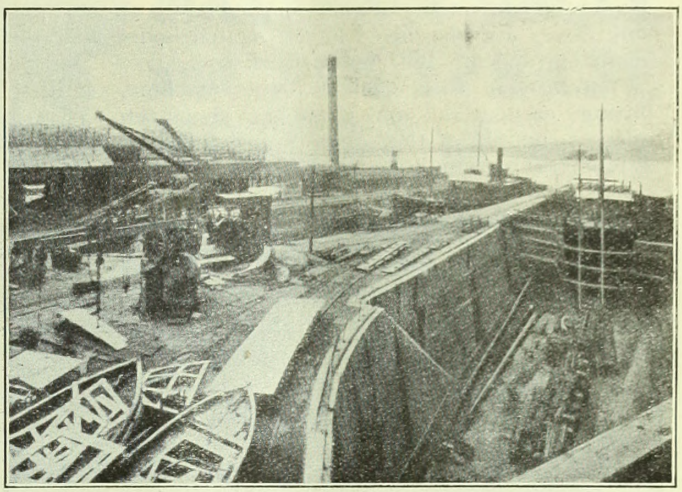


FIG. 1.

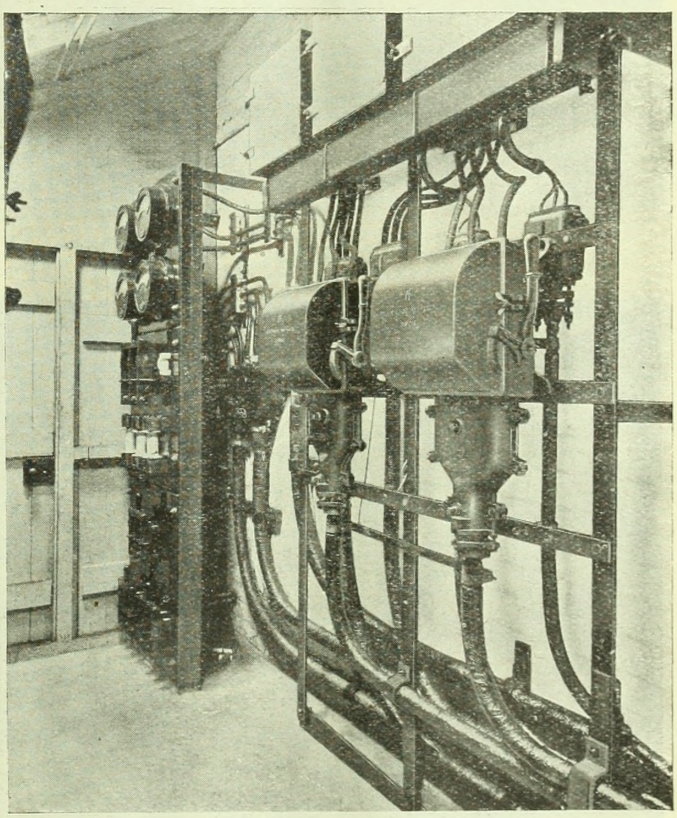


FIG. 2.

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are so constructed that no fumes can pass from the switch compartment to the busbar compartment.

The voltage on the L.T. side of the power transformers is 440. The distribution, while not being totally enclosed, has the gear at the back of the individual panels separated by sheet steel divisions, expanded metal doors being placed at both ends.

For the lighting supply a main panel, as shown in Fig. 2, is installed in the office block. By the side of this panel are two "Salford" ironclad switches, which act as isolating switches from the sub-station to the dock department. Smaller emergency switches and link boxes are also fitted at the switch house near the main entrance to the engine works.

Throughout the whole of the machine, smiths', fitting, carpenters', and plumbers' shops, etc., electric motors, mainly of the squirrel-cage type, are used for driving the various machine tools and other mechanical appliances. In the main, standard sizes of motors have been adopted, a large majority being either 15 or 30 h.p.

For the main plate-bending rolls, however, which are shown in Fig. 3, the driving motor is of 100 h.p., and the motor for the screwing-down gear of 20 h.p., both machines being of the slip-ring type. The main dimensions of the rolls are: Length 25 ft. 2 in., dia. of one large roll 15 in., and of two smaller rolls 12 in. Plates 25 ft. long and 1 in. thick can be handled. There is no actual limit to the width, this being mainly governed by the standard type of plate dealt with in the yard, which is usually not greater than 5 ft. The screwing-down motor is seen on the right-hand side of Fig. 3, but the 100 h.p. motor, though easily accessible, was not in such a position as to admit of being photographed. The top of it, however, can be seen in Fig. 4, which shows how some of the control gear is accommodated in a shed. In the middle is a pedestal-mounted oil switch which controls the power distribution locally in the yard. To the right is the top half of the control unit for the 20 h.p. motor, consisting of an oil circuit breaker and an oil-immersed reversing drum type controller which is interlocked with the oil switch as shown, so that, should the breaker trip, the controller must be brought to the "off" position before the breaker can be closed again.

In the fitting shop the various machines are grouped, and motors of 15 h.p. or 30 h.p. are used for driving the groups through counter-shafting. Thus boring machines form one group, slotting machines a second and brass finishers a third. A totally enclosed squirrel-cage motor, shown in Fig. 5, drives a double spindle polisher; this, in common with the majority of the other motors in the workshops, is controlled by a star-delta starter.

The General Electric Co., Ltd., acted as main contractors through their Newcastle branch, the motors, switch and control gear referred to having been manufactured at their Witton Works. The main and a large part of the auxiliary cabling was produced at the G.E.C. Associated Pirelli-General Cable Works at Southampton.

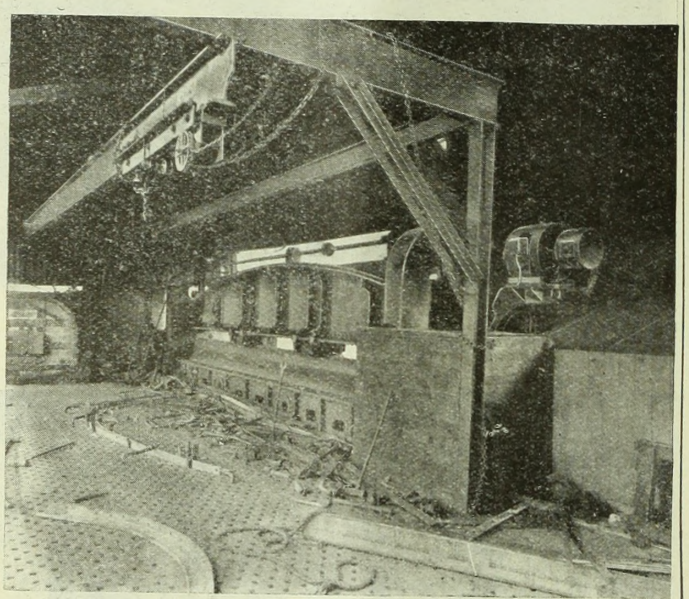


FIG. 3.

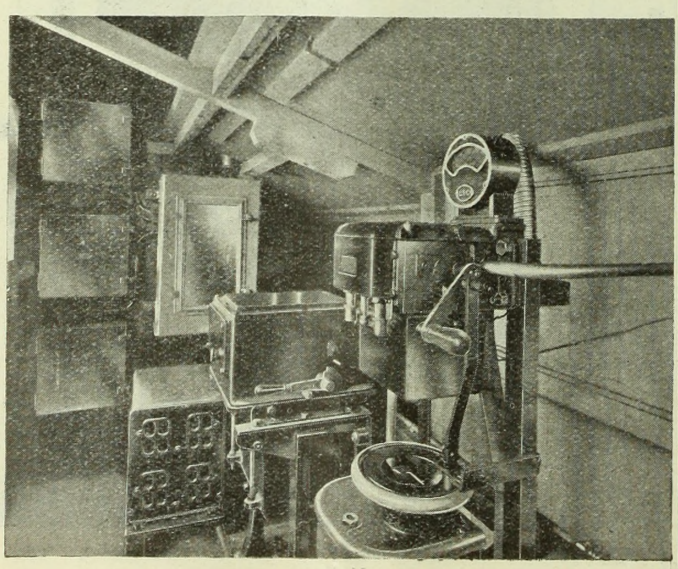


FIG. 4.

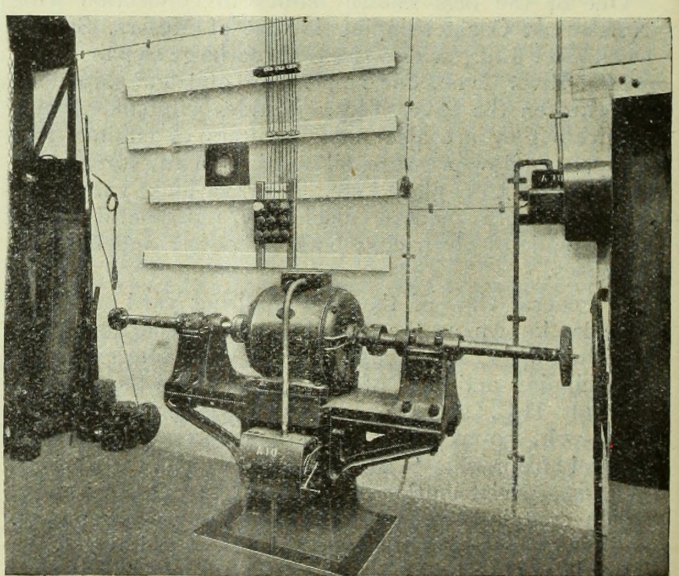


FIG. 5.

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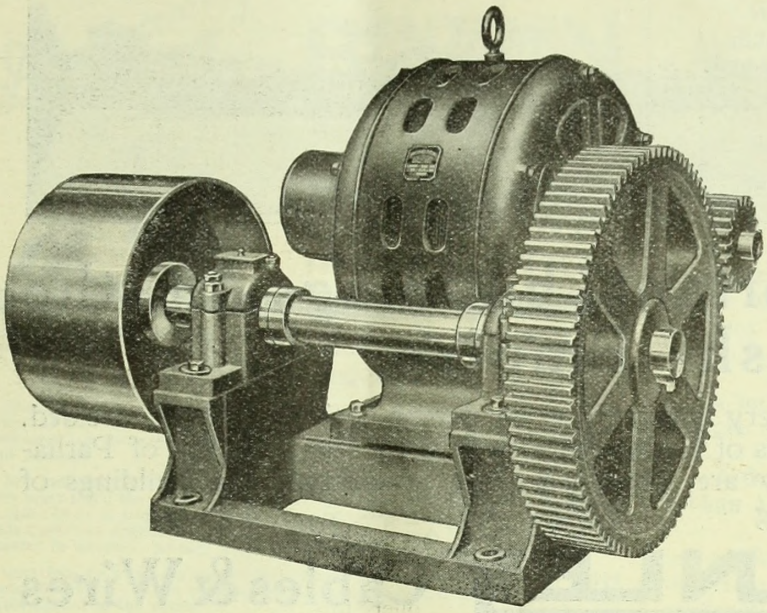


Illustration shows a 40 B.H.P. Standard Back-gear Motor.

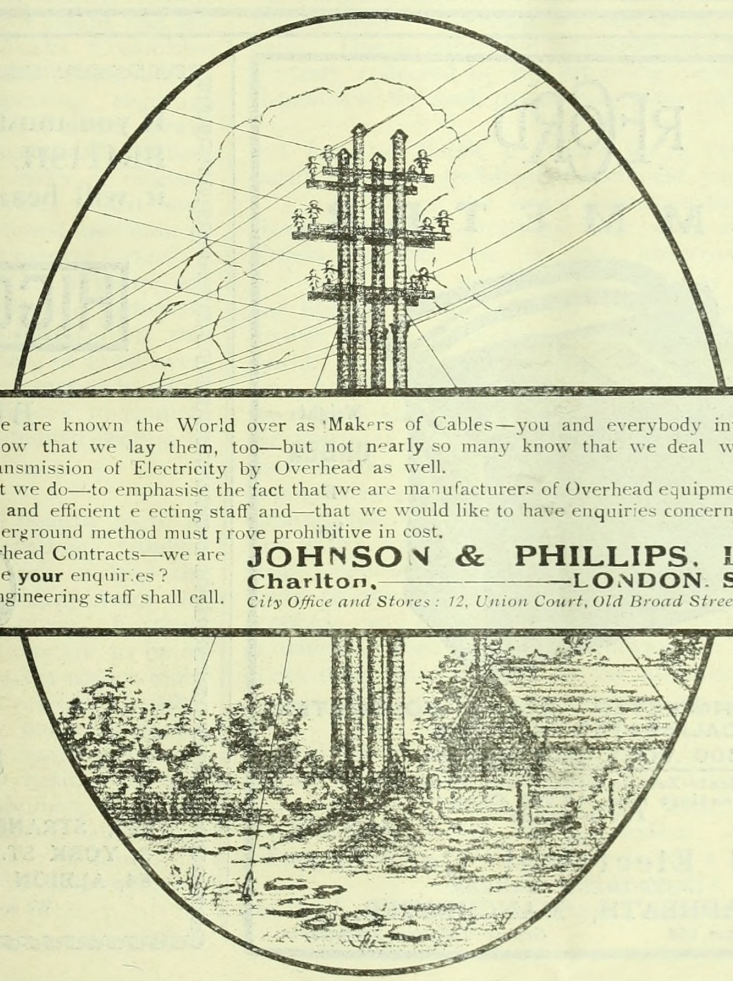
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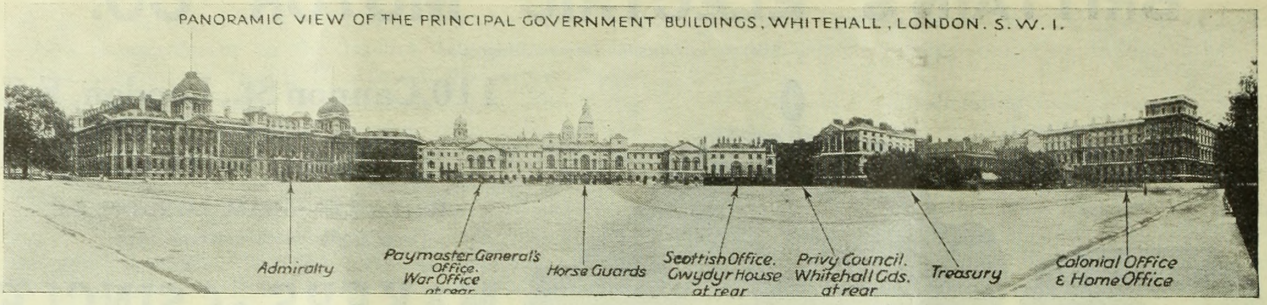
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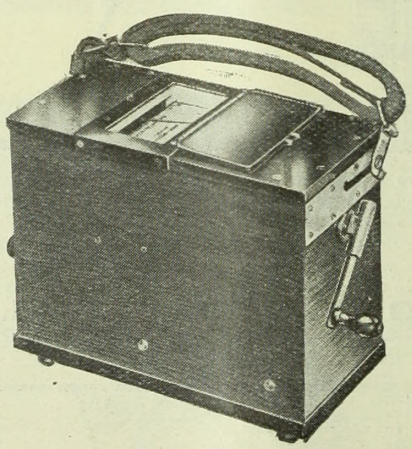
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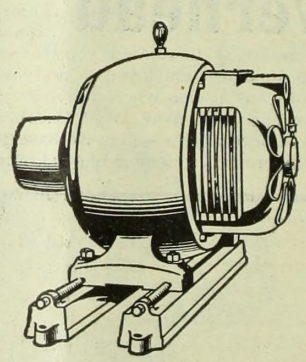
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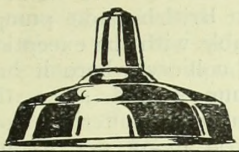


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Current Topics.

There is an aspect of the recently settled dispute between the municipal employees of Fulham and the local Highways Works Committee which leaves a nasty taste in the mouth of self-respecting electrical men. In effect, the Fulham power station staff, whom one regards as technically skilled, and therefore of a somewhat higher order of intellect than the purely unskilled manual worker, joined issue with the Trades Union in unconventional methods to force a decision in favour of the dustmen on strike. I have nothing to say on the merits of the dispute, nor do I offer an opinion as to which party had justice on its side. What I certainly deplore, however, is this preliminary warning that a class of men, of good average education and training, should be tempted to adopt the tactics of Socialistic Labour, and seek to emulate the objectionable practices of the Communist section of our industrial population.

The Fulham Precedent.

It is not a good sign, it is not a healthy sign, to witness these intelligent workers supporting a troublesome and unpopular minority who seek to lead the saner working men of this country away from the straight path of honour and common-sense. Furthermore, if the brains of our power stations are to be as prone to disaffection as any illiterate street corner mob, abjured to break the law by Bolshevist orators, the ultimate safety of our electricity supply undertakings is imperilled, because this small body of avowed enemies of our present social system will not hesitate to use any means, however criminal and inhuman, to bring about their visionary Utopia, where nobody works and everybody gets unlimited pay for doing nothing. I hope the Fulham precedent will not be followed elsewhere.

I well remember some years ago listening at a music hall to a then popular comedian singing a song anent his house and its manifold advantages, among which figured the refrain, "Wiv a ladder and some glasses, you could see the 'Ackney Marshes; if it wasn't for the 'ouses in between." Well, in spite of the recent addition to Hackney's generating resources, it would appear that, with or without the ladder and glasses, you would have been unable to locate visually either the marshes or any other part of Hackney the other day, seeing that this borough is one of the latest to figure in the breakdown list. Practically the whole of the district was in darkness for upwards of twenty minutes the other evening through a failure of the electricity supply.

"With a Ladder and Some Glasses, etc."

As an interesting and instructive example of how lies are spread about and insidious anti-electric propaganda encouraged by competitive interests, a recent report of the Chief Officer of the London Fire Brigade was so distorted as to convey the impression that no less than 1,148 fires were caused by defective electric circuits! No wonder the public are mistrustful of the safety of electricity in their houses. The offending paragraph, which first appeared in a prominent daily, read as follows:—"Of the total, 1,148 calls were due to fires caused by defective electric circuits." The actual wording of the Chief Officer's report, since personally confirmed by him, is:—"Of the false alarms . . . 1,148 were due to defective electric circuits"—inferring, of course, *Fire Alarm Circuits*. One is prompted to ponder the amount of the gratuity collected by the offending reporter who was responsible for such gross misrepresentation.

A Greater Than Ananias.

I have to thank a reader for a very interesting cutting from a well-known technical journal in which the writer expresses the opinion that electricity has seen its best day, due to the improvements which have been rendered possible in gas lighting by the thorium mantle, which, the report further states, renders gas the best illuminant in the world. In our mentor's opinion, gas lighting would have beaten electricity out of the market some time since *if it had not been for the immeasurably greater excellence of the latter in all that concerns cleanliness, heating, and purity of air.* But, he goes on to say, improvements are daily being made in gas lighting, unparalleled by anything that is going on in electricity. The italics are mine, and sum up the worth of such an absurd pronouncement without need for further comment on my part. But the real joke is that the prophesy was made in 1905 and the technical journal in which it then appeared is always to the forefront in its descriptive articles on the advance of electrical science, including such inventions as the gasfilled lamp.

Never Prophesy Unless, etc., etc.

"Wherever you see a head, hit it," used to be the slogan of the wild Irishmen; but latterly it would appear to have been amended to the more modern admonition—"Wherever you see a lamp, smash it." According to the chairman of the Dublin Electricity and Public Lighting Committee

The Irish Temperament.

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in a letter to the *Irish Times*, no less than 3,000 panes of glass in public street lamps in that city have been deliberately broken in the course of the last six months, the cost of the damage amounting to £250, which, in the natural course of things, Irishmen will have to refund. It is difficult to understand the temperament which indulges in such purposeless and wanton destruction of property which is to the common interest of the inhabitants of any big city; and, failing this appeal to the common-sense of the offenders, it is probable that the only remedy for such an unfortunate state of affairs will be that proposed by the chairman in his report, viz., the entire withdrawal of public lighting in the areas affected. Possibly this is what some of the "corner boys" are wanting to happen.

A Business Manager for Large Municipalities.

The Corporation of Hull is said to be seriously considering the advisability of appointing "a general commercial manager" for the city, and the proposal, like all novel and unconventional suggestions, is leading to considerable controversy. Personally, I think the Hull Corporation have hit on a very excellent idea, and one which might be adopted with considerable advantage by other cities and towns of greater civic importance than Hull, and to the benefit, financial and otherwise, of the ratepayers concerned. After all, the local government of any big city or town is essentially a business proposition, and just as susceptible, if not more so, to shrewd business and commercial methods as any privately-controlled enterprise, however large. Under present arrangements, local government by committees of town and city councils is government in name only. The actual control is invariably vested in a series of departmental managers who, in most cases, act entirely independently of one another, and, in too many instances, are allowed too much power in the way of spending public money, and incurring liability for heavy commitments which no sane business manager would be a party to.

A business manager of any big town or city, vested with the necessary authority, could save his own salary, even of four or five figures, many times over in the course of twelve months, to say nothing of the improved services and reduced dislocation of business at present resulting from the existing policy of "too many cooks." Vote for Bloggs and better lighting is an election parrot cry, which has as much real meaning as if actually uttered by the bird in question. If Bloggs gets in as the representative of his ward, he is just as likely to have sufficient influence to bring about better lighting of the township as a parrot, even if he be elected to the street lighting committee and become chairman thereof. A business manager, of the Geddes type, would be an invaluable adjunct to the corporations of quite a few towns and cities I know of. He would keep a useful check on expenditure, co-ordinate street repairs and upheavals, control the various buying departments, supervise contracts, and see that the ratepayers' money was spent to best advantage. Last, but not least, he would be free from the deadly influence of party politics which overshadows all sane municipal control.

By Way of Contrast.

An old friend and valued correspondent takes me to task over my remarks under this head in the issue of ELECTRICITY, dated October 26, anent the failure of certain pumps at the Redding Pit rescue operations. My correspondent draws attention to an error in my report of the circumstances, and states that the actual facts were as follows:—"A number of pumps were used, and all British-made pumps worked without the slightest trouble with the exception of one, which was sent from a colliery where it had been lying uncared for and unprotected since the miners' strike, and the motor, naturally suffering from exposure, gave trouble. A 350-gallons per minute German pump was taken directly from service, and was therefore in good working order." I am delighted to receive this revised version of the performance of British pumps, and regret that my correspondent should have taken my remarks in a different spirit to that in which they were written. I am a staunch advocate of British goods every time, and any instance of their failure or apparent inferiority of performance has been put forward with a view to stimulating British manufacturers of such goods to look into the matter, and remedy as early as possible any weaknesses of design and manufacture as compared with foreign competitors' products. My remarks on the German pump were intended to bring about such improvement, on the assumption that my original informant's report of what happened was substantially correct.

ELEKTRON.

RADIO-FREQUENCY AMPLIFICATION.*

BY A. CHENIK.

(*Concluded from page* 587.)

Fig. 3 indicates how this system is carried out; this is sometimes called reactance capacity, rejector circuit, and other names, the principle in each instance being identical. An inductance, L, shunted by a variable condenser, C, is included in the anode circuit of the first valve, and the potentials across the circuit LC are communicated to the grid circuit of the second valve. The amplified oscillations in the anode circuit of the first valve set up oscillating currents in the circuit LC, and these result in potential differences being set up across the terminals G and F. It is apparent that the function of the condenser is to tune the inductance to a particular wave-length; when this circuit is tuned to some wave-length, it will be found to possess a theoretically infinite resistance to alternating currents of a frequency corresponding to that wave-length; that is why the circuit is often termed a "rejector" circuit, i.e., currents of a particular frequency cannot get through. You will see that this arrangement operates in a very similar manner to resistance-capacity coupling, and that the tuned anode simply takes the place of the resistance. The resistance (or more properly, the impedance) of the tuned coil may be of the order of several hundreds of thousands of ohms to the frequency of the wave-length it is desired to receive, and, therefore, the largest possible potential

* Paper read before the S.A. Inst. of Electrical Engineers.

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difference will be set up across it, and transferred through the coupling condenser to the next grid. At the same time, the direct-current resistance of the induction coil is only a few ohms, and so there is a low resistance path to the plate for the direct current supply from the H.T. battery. This is a great advantage over resistance-capacity coupling, as it allows a lower voltage H.T. battery to be used with a corresponding reduction in extraneous noises. This method is also very efficient even for wave-lengths as short as 100 metres, and equally so for the longest wave-lengths now in use. It will be seen in this arrangement that

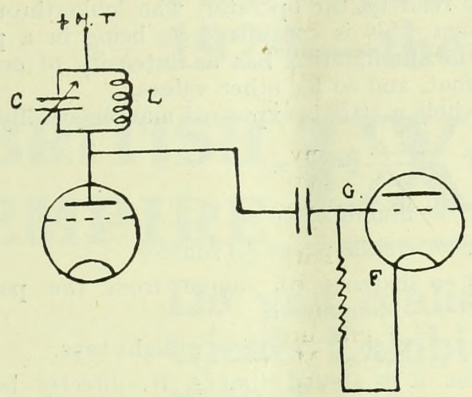


FIG. 3.—TUNED ANODE.

the anode coil is equivalent to a one-to-one transformer, and, theoretically, each will produce identical signal voltage strength across the input of the next valve. The anode coil, however, is more simple to construct —there is no secondary winding having similar resonance properties to its primary—and it is not, therefore, surprising that, in practice, the tuned anode method, in the hands of the average experimenter, will give results far superior to any other.

I have not said anything about introducing a reaction coil into the amplifier. This is easily done by inserting a suitable coil in the plate circuit of the detecting valve and bringing it back to couple on to the aerial circuit; or it may be pointed out that where reaction to the aerial is forbidden, the reaction coil can be coupled with the tuned anode intervalve coupling coil, so making the detector valve oscillate without so much radiation from the aerial circuit.

One slight disadvantage of this type of coupling is that some extra means is necessary for preventing self-oscillation of the high-frequency valves. When care is taken to keep the impedance of the input circuit high, and the anode circuit also includes a high impedance, oscillations are easily set up. With most valves, tuning of the anode circuit to the same wave-length as that to which the grid is tuned causes the valve to set up oscillations continuously, the reaction being provided by the inter-electrode capacity of the valve. The amplifier must, therefore, be stabilised, either by applying a positive voltage of, say, 3 or 4 volts to the grid of the H.F. amplifying valve, by dimming the filament, by providing some form of *reverse* magnetic reaction to stop the oscillations, or sometimes it is advisable to connect the grid of the H.F. valve through the leak resistance to the positive instead of to the negative of the L.T. battery.

I would also like to mention that as regards the variable condenser shown across the inductance coil, that condenser should be kept as small as possible, a usual value being from .0001 to .00025 mfds. Every micro-microfarad across the coil increases its wave-length by an appreciable amount, and the zero capacity of the shunt condenser should be very low indeed.

Mr. Barnett, during the discussion, said: Mr. Chenik is certainly correct, as far as I can gather from practical experience, in saying that the tuned anode offers the easiest solution to the difficulties of high-frequency coupling. With radio frequency coupling, using the tuned anode method, alluded to by Mr. Chenik, the amplifier is liable to break into self-oscillation when the tuned anode circuit is adjusted to the frequency of the incoming oscillations, due, as Mr. Chenik remarked, to the inter-electrode capacity of the valve causing reaction; and a recent development of this type of circuit is for neutralising the inter-electrode capacity of the valve, and so enabling one to prevent the circuit from breaking into self-oscillation without either distuning any of the circuits or dimming the filaments. This method is applied in what, I believe, is called the Neutrodyne Receiver. It would appear to offer a very satisfactory solution, because it enables one to adjust all the circuits to maximum sensitivity. It consists merely of a very small fixed condenser having a capacity equivalent to the capacity between the electrodes of the valves, and so applied as to neutralise that capacity. I think many of the gentlemen here have seen articles dealing with this particular receiver. If anyone has had actual experience of it, I would be very glad to hear from them.

Mr. A. Chenik (in reply): From what I have read in connection with the Neutrodyne Receiver, it appears to me it is in very much the same position as the Armstrong Super-regenerative Circuits: that is to say, it is very difficult for the amateur to work it in its present stage of development. There is no doubt that this Neutrodyne Receiver offers very great scope; but it is rather a difficult subject to tackle at the present moment.

A NEW DRY BATTERY: ITS APPLICATION TO TELEPHONE TRADE

According to *Telephony*, of Chicago, after extensive experimentation and development, the Twin Dry Cell Battery Co., of Cleveland, Ohio, U.S.A., offers to telephone exchanges an improved dry battery, a description of which is very interesting.

Years ago a substitute was brought out for the old sal ammoniac wet battery in the form of the present-day round dry battery. This was a big improvement, in that a cheap and portable source of current was made possible.

To-day we have a dry battery differing from the round one only in arrangement of ingredients. This, it is claimed, is an improvement, because it makes possible a fuller use of these ingredients, resulting in longer life, and hence greater satisfaction to the user. Every battery is waterproof, it is stated, and, therefore, absolutely no loss results from using the cells under any wet or damp condition.

Twin-cell construction uses a separate flexible waterproof case as a container, which protects the battery

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even while under water. Zinc is used entirely on the inside of the container in plate form, where it is protected from moisture and its entire amount and area is available for use. Thus it may be entirely consumed without rendering the battery useless. Likewise, because the black depolarising mix is split up into thin sections, a fuller use is obtained from it, and, consequently, a high voltage is maintained.

This construction is very similar to storage battery practice where alternate plates are used to increase plate area and make the battery efficient. It is obvious that batteries constructed so as to permit total exhaustion will give unusually long life.

Questions and Answers by Practical Men.

RULES.

QUESTIONS : *We invite our readers to send us questions, preferably on technical problems that have arisen in actual practice. Questions which we consider of sufficient interest to our readers will either be replied to under "Answers to Correspondents" or replies will be invited from our readers. One shilling will be paid for the question which we select for competitive replies in this column.*

ANSWERS : *A fee of 10s. will be paid for the answer which we consider shows the greatest merit, and 5s. for the one we select as second best. In judging the replies importance will be attached to clearness and conciseness, as well as accuracy. The Editor reserves the right to make no award, or to accept only one reply, if, in his opinion, the answers received do not possess sufficient merit. Competitors desiring the return of their manuscripts, if unaccepted, should enclose stamped addressed envelope.*

Write on one side of the paper only, and if diagrams are sent, draw them on a separate sheet of paper attached to the manuscript. Competitors may adopt a "nom de plume," but, both in the case of questions and answers, the competitor's real name and address must be sent with the manuscript as a guarantee of good faith. No correspondence will be entered into with regard to successful replies. The Editor's decision is final.

Commencing with Question No. 101, a Diploma of Merit will be awarded to the six competitors who win the first or second prize the most times during the next twelve months.

The words "Questions and Answers" or "Q" and "A" should be placed at the top left-hand corner of all letters intended for this column.

QUESTION NO. 171.

I have a 10 h.p. motor and the cone insulation on the vee rings has given out. How can I build this up again?—"A. C. WARNER."

QUESTION NO. 172.

Can any reader give working details of the method of producing power by means of motor generators for motion picture work? I require 75 amperes at 75 volts.—"CINEMA OPERATOR."

(*Replies to Questions Nos. 171 and 172 must be received not later than December 1, 1923*).

Answers to Questions.

QUESTION NO. 165.

I hear that in America they have an instrument known as a foot-candle meter. What is this for, and how does it work?—"WIREMAN."

REPLIES TO QUESTION NO. 165.

The first prize (10s.) has been awarded to "M. M." for the following reply :—

How the particular instrument "works" is somewhat difficult to explain, there are many such instruments ; they are simply photometers calibrated in foot-candles. The illumination termed one foot-candle is that given at a distance of one foot by a source of one candle-power. Some instruments compare the illumination from a source with that given by a standard lamp ; there are several types of standard lamps used for this purpose. Other instruments, again, are calibrated so that by noting a particular specimen of type the operator can read, he can at once read off the illumination on the instrument in foot-candles.

If "Wireman" will get almost any text-book on light, he will there find an easily understandable explanation of the photometer. They may, of course, be calibrated in any particular units, but that is simply a matter of convenience.

One particular instrument is held so that the light illuminates, usually by reflection, a printed card. On this card are a number of sentences in different sizes of type. Then if a certain sentence can be just comfortably read by the operator, who looks through the instrument, this is considered as being in a position where the illumination has an intensity of one foot-candle foot, and so for other values.

The whole matter is expressed mathematically by :—

$$I = \frac{c.p.}{d^2} - \cos \alpha$$

where I = illumination

$c.p.$ = candle-power (of source)

d = distance of source from the point illuminated.

α = angle of incidence of light rays.

Suppose it is found that 5 ft. directly below a lamp the foot-candle meter reads 2, then

$$2 = \frac{c.p.}{(5)^2}$$

$c.p. = 2 \times 25 = 50.$

(Note that in this case $\alpha = 0$.)

But if we are at some distance, say 4 ft., from the vertical position under the lamp, between lamp and photometer will then be

$$\sqrt{5^2+4^2} = \sqrt{41} = 6.4 \text{ ft. (approx.)}$$

$\cos \alpha$ then $= \frac{5}{6.4}$

and foot candles $= \frac{50}{41} \times \frac{5}{6.4} = .95$ on the horizontal plane.

"M.M."

[No second award is made.]

MANCHESTER WIRELESS SOCIETY.

At the meeting of this society, held in Houldsworth Hall, on October 24, a lecture was given on the construction of the Cossor valve, and proved very interesting to the large number of members present. It was illustrated by means of lantern slides loaned by the Cossor Valve Co., and the lecturer, Mr. Y. W. P. Evans, A.M.I.R.E., outlined the various points which are special features of this type of valve, and compared them with other valves of different makes.

Following the lecture a discussion took place on the merits of various valves, and the members gave their several experiences, one or two emphasising the advantages they had gained by using the Cossor valve, and one member went so far as to say that all his best results had been obtained by the use of these valves. It is the intention of the society to give another lecture later on another make of valve.

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ELECTRICAL BUYERS—

Are you getting ready for 1924—the year of the great

BRITISH EMPIRE EXHIBITION?

Do you realise that the greatest Electrical Exhibition ever made will be within it?

Have you thought how this must educate the public and stimulate the use of Electricity?

Of course

The C.M.A.

Regd. Trade Mark 42219-20-21.

will be there.

But don't wait till then to get ready, and Make your Cable contracts for next year in good time.

Members of the Cable Makers' Association :—

The Anchor Cable Co., Ltd.
British Insulated and Helsby Cables, Ltd.
Callender's Cable and Construction Co., Ltd.
The Craigpark Electric Cable Co., Ltd.
The Greengate & Irwell Rubber Co., Ltd.
W. T. Glover & Co., Ltd.
W. T. Henley's Telegraph Works Co., Ltd.
The India-Rubber, Gutta-Percha & Telegraph Works Co., Ltd.
Johnson & Phillips, Ltd.
Liverpool Electric Cable Co., Ltd.
The London Electric Wire Co. and Smiths, Ltd.
Siemens Brothers & Co., Ltd.
St. Helens Cable & Rubber Co., Ltd.
Union Cable Co., Ltd.
Western Electric Co., Ltd.

Advertisement of the Cable Makers' Association, Sardinia House, Sardinia Street, London, W.C.2.

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P. D. Q.*

By Miss Anne Barnes
(Travelling Chief Operator, Iowa Independent Telephone Association, Des Moines, Iowa).

Catherine Hope was ready to record her first long-distance call, without supervision. As she grasped a plug and waited, she felt that she had already encountered every type of human being who used the telephone. And then a signal appeared. She answered, "Long Distance."

"Hello. Give me Crystal City, two, three, four, nine."

"What is your number, please?"

"I just told you—Crystal City, two, three——"

"I mean your house number."

"Three five eight Glenwood Ave."

"Oh, that isn't what I mean—your telephone number."

"Why didn't you say so?" blustered Mr. Peter D. Quick, who is noted for his temper.

"I did; what is it?"

"Capitol seven, seventy-seven."

"Capitol seven, seven, seven?"

"Have your own way, but make it snappy."

"And what number do you want?" again nervously asked Catherine.

"Crystal City, two, three, four, nine," roared Mr. Peter D. Quick.

"Crystal City two, three, four, nine?"

"Say, are you a parrot?" yelled Mr. Peter D. Quick.

"What is your name, please?"

"My name is Peter D. Quick. The "D" stands for a family name that I never cared for, so wouldn't use; the result was I was left out of an old aunt's will. I live at three five eight Glenwood Avenue, or three-fifty-eight, suit yourself. I am married, have no children, we keep a dog and a cat, have a victrola and a radio ——"

"All that is unnecessary, sir. We merely——"

"——and last summer we didn't have a bit of luck with our roses. I tried a little garden, too, but the neighbour's chickens got away with that. Our house is all modern and well covered by insurance; there is a cement walk from the street, and we have a garage. I am 40 years old; my wife says she is younger, but she doesn't look it; we have a piano, keep a maid, and had the front bedroom papered last week, and I want——"

"Did you want Crystal City two, three, four, nine?"

"Yes," bellowed Mr. Peter D. Quick.

"The circuit to Crystal City is busy. We will call you."

"Let the call go. Nowadays a man has to give his family record dating back to the *Mayflower* every time he places a ten-cent call!" And the receiver went down with a bang.

B.E.A. Show-case Exhibits.—Complete arrangements have now been made by the B.E.A.M.A. for a limited number of exhibits in standard show-cases. We believe that this scheme will be well supported. Some exhibitors are well advanced in their intended displays of this nature.

* *Telephony*, Chicago.

Trade Notes.

A handsome illustrated price list, clearly demonstrating the simplicity of C.T.S. wiring, is to hand from **Johnson and Phillips, Ltd.** (Charlton, S.E 7).

Self-aligning adapter bearings, ball-bearing plummer blocks, and shafting hangers are dealt with in a catalogue received from the **S.R.O. Ball Bearing Co.** (115, Southwark Street, S.E.1.).

A new totally enclosed relay type crane control panel with inverse time element overload relays has been designed by **George Ellison** (Perry Bar, Birmingham). The advantages of the design and distinctive features of the construction are set out lucidly in List No. 323.

Another post-card circular has just been issued by the **Cambridge and Paul Instrument Co., Ltd.**, illustrating the Cambridge pyrometer tester. Readers desiring further particulars should write to 45, Grosvenor Place, S.W.1, asking for List No. W191.

Spotlight projectors and Mazda gasfilled projector lamps of 100 to 1,000 watts form the subject matter of a new illustrated descriptive price list just issued by the **British Thomson-Houston Co., Ltd** (Mazda House, 77, Upper Thames Street, E.C.4). The projectors are particularly adapted to "spot-lighting" in theatres, shop-windows, dance-halls, etc., as well as for the illumination of clock faces and small signs. The Tungar battery charger (for use in A.C.) is described, and some of its numerous uses dealt with in an illustrated B.T.-H. booklet, No. L 288.

An abridged edition of their 12th edition Telephone Catalogue has been issued by the **Sterling Telephone and Electric Co., Ltd.** The prices given have been revised to date. Included are inter-communication telephones, battery call and magneto telephones, "Primax" interphones, C.B. "reply" and "call" telephones, switchboards and accessories, including bells, buzzers, indicators, batteries, wire and cables, volt and ampere meters, etc.

We have received from **Marconi's Wireless Telegraph Co., Ltd.**, two pamphlets. One is an illustration of their "Y.B. 1" 100-watt portable telephone and telegraph station, fitted with the Marconi wireless bell. The illustration shows the main transmitter and receiver constituting their "Y.B. 1" set, the wireless bell transmitter, the wireless bell receiver, the H.T. battery, and charging switchboard. The general lay-out of these sets is fairly well known to all interested parties, and the Marconi bell transmitter and receiver is already securing the position that the Marconi Co.'s apparatus held when first introduced, and which to-day is maintained. The other pamphlet, No. 219, describes and illustrates Marconi portable and semi-portable receivers, and emphasises the various points in their construction. As the various receivers shown have different types of high-frequency amplification systems, the pamphlet is preceded by some notes on these systems, and their respective advantages emphasised. These notes make very interesting reading. The apparatus has, of course, no reference to broadcasting as such, although some of the sets could no doubt be efficiently used. The main object of the list is to catalogue sets for military purposes, time signal reception for geographical survey expeditions, receiving Press, and for irregular and emergency reception in connection with small telephone and telegraph transmitting stations. As far as appearance goes, the sets are neat and compact, and provision is made for housing telephones, spare valves and parts. These points, however, need not be dilated upon, as the company's apparatus is always up to the 100 per cent. efficiency standard. The pamphlet concludes with a list of stations transmitting time signals, meteorological reports, and other items of general interest.

Freemasonry.—At the installation meeting of the Kelvin Lodge on October 26 last, Mr. Andrew Forbes Dick was installed as Master for the ensuing twelve months, and at the banquet which followed he was well supported by his officers for the year, as well as by a very large muster of the members of the Lodge and their guests, including Mr. Chas. F. Quicke, Mr. F. P. Baxter, Major Pike, Mr. L. E. Wilson, Mr. Gillespie, Mr Hobdell, Mr. Ellis, and, indeed, quite a number of gentlemen well known in the electrical and engineering professions. As a matter of fact, there were in all 111 present at a most enjoyable evening, the speeches being commendably brief and in several instances very humorous, while the musical programme was excellent.

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THE N.A.S.E. AT THE B.T.-H. CO.'S LIGHTING SERVICE DEPARTMENT DEMONSTRATION ROOMS.

Thirty-two members of the National Association of Supervising Electricians attended a demonstration of domestic and industrial lighting at the B.T.-H. Lighting Service Dept. demonstration rooms, 15, Savoy Street, Strand, W.C.2, on Tuesday evening, the 23rd Oct. Mr. W. E. Highfield, M.I.E.E., the Chairman of the Assocn. was unable to be present and, in his absence, Mr. Brammer deputised.

The proceedings commenced in the industrial demonstration room, the demonstration being conducted by Mr. W. E. Bush, Head of the Lighting Service Dept. Commencing with an obsolete system of lighting consisting of drop cords and enamelled iron shades, unfortunately a replica of the systems which obtain in many factories and workshops to-day, Mr. Bush pointed out that it was impossible to execute good work under such conditions of lighting. Apart from the inability of a fitter or machinist to see clearly, the dismal miserable surroundings were depressing and a sure drag upon production.

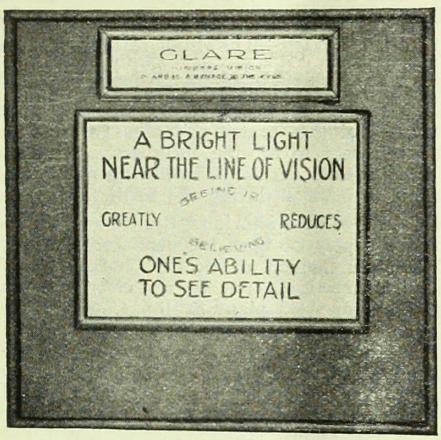


FIG. 1.

Continuing, Mr. Bush said that in a large number of factories it was realised that the antiquated system of lighting was wrong, and in many instances an effort had been made to improve the lighting conditions, but the tendency appeared to be to install a few large light sources irrespective of their location and the quantity of light they produced at certain points in the workshop. As an example, Mr. Bush removed the antiquated system and replaced it with a bare 1,000 watt lamp, fitted in the centre of the demonstration room. He then invited the members to take readings at their tables with a foot-candle meter, and it was found that the light intensity immediately under or near the lamp was high in comparison with that measured at the tables further away from the source of light. The excessive glare was remarked upon by the members.

It was then demonstrated that a number of smaller bare lamps, totalling in candle-power that of the 1,000 watt unit previously referred to, if placed in more or less symmetrical positions, would even up the amount of illumination on the tables, but the glare still remained and a large proportion of the light was thrown upon the ceiling. Shades were then fitted over these lamps, and it was found that the intensity of light upon the tables had considerably increased.

Mr. Bush then proceeded to demonstrate the essential features of the ideal system of illumination for industrial interiors. Various sizes of units, composed of R.L.M. reflectors and bowl enamelled gasfilled lamps, were shown at different spacing distances and mounting heights. Incidentally the folly of using lamps at lower than their rated voltage was pointed out, the members witnessing that a 10 per cent. decrease in voltage resulted in 30 per cent. less light output.

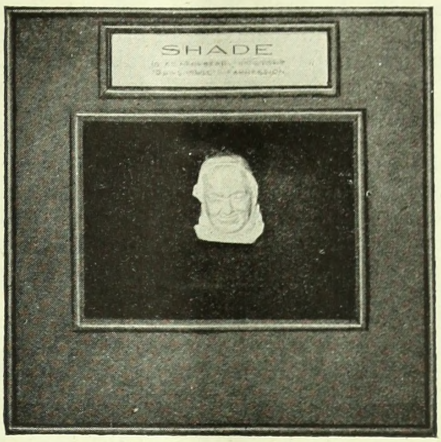


FIG. 2

A number of interesting cabinets were then shown, all of which demonstrated lighting effects. One of them, illustrated in Fig. 1, proved that a bright light near the line of vision greatly reduced one's ability to see detail. The cabinet contained a lamp slightly protruding through a card. When this lamp was lighted it was almost impossible to see any of the lettering upon the card.

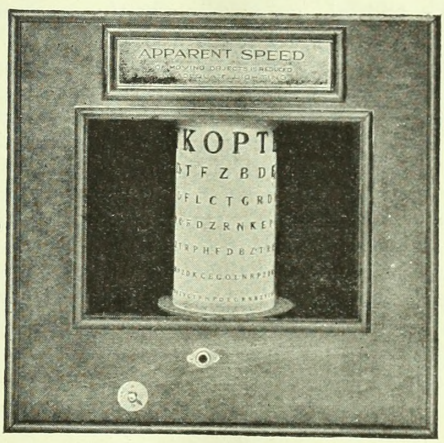


FIG. 3.

Fig. 2 shows a cabinet which illustrated that shade is quite as necessary as light to give objects expression. It contains a white plaster head fitted against a black background. Lamps connected to thermo-flashers produced intermittent illumination from different angles. Under the influence of the various light sources the features of the face "appeared" to alter considerably.

A third cabinet, illustrated in Fig. 3, proved that the apparent speed of moving objects is reduced by adequate lighting. The white cylinder, illustrated, is free to rotate at constant speed. Under poor illumina-

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tion the speed "appears" to be faster than when viewed under light of high intensity. It is well known that the eye requires a certain amount of time, and the expenditure of a certain amount of effort, to see an object clearly. Under good lighting, the demonstration proved that the time required is less, and the effort required smaller, than under poor lighting. The effect of good lighting, therefore, in industry is obvious. It means that under good light production speeds up without strain or added exertion on the part of the operators.

As regards domestic lighting effects, it was clearly shown that direct unshaded light is not only unnecessary and produces unpleasant eye-strain, but that it acts as an irritant to the nerves. As an alternative the use of units which produce soft light and at the same time add to the decorative effects of the home, was advocated, the demonstrations showing that there is practically no limit to the artistry of designs which can be executed upon glassware and silk-covered shades, and that true artistic decorations can be secured by the careful selection of lighting fixtures and shades.

At the conclusion of the meeting Mr. Brammer thanked Mr. Bush on behalf of the members of the N.A.S.E. He said they had all been very interested in the demonstrations, and there was no doubt that the policy of more light in the home and factory was justified. He hoped that on some future occasion they would have the opportunity of visiting the demonstration rooms again to witness other lighting effects which, he understood, were already in preparation.

THE WIRELESS EXHIBITION.

Opened yesterday at the White City, Shepherd's Bush, W.12, the All-British Wireless Exhibition and Convention, organised in conjunction with the National Association of Radio Manufacturers by Bertram Day and Co., Ltd., is a most instructive commentary on the healthy state of this flourishing industry. Besides interesting representation by all the leading makers and dealers, one of the most novel attractions is the demonstration by the British Broadcasting Co. 2 L.O. as the daily dispenser of wireless entertainment is doubtless familiar to millions of "listeners-in," but very few have more than a bare idea as to how the concerts are conducted. At this Exhibition the B.B.C. provides something in the nature of a peep behind the scenes at 2 L.O., showing in an interesting manner the way in which the concerts are broadcast from the London station. This takes place every afternoon between the hours of 2.30 and 3.30. The Exhibition will remain open till the 21st inst.

Unauthorised Strike on H.M.O.W. Contracts.—This strike has now terminated, the men having restarted work on Monday, the 5th inst., and the request of Mr. Leonard G. Tate, Secretary, London branch of the N.F.E.A., of October 10 that any employer of electrical labour should communicate with him before engaging additional men is therefore now withdrawn.

Increase in Motor-ship Construction.—According to the November issue of *The Motor Ship*, at the end of the last quarter there were motor-ships under construction in the United Kingdom with a gross tonnage of 254,426. A year previously the corresponding figure was 126,437, showing an increase of more than 100 per cent. in twelve months. In the same issue there is a fully illustrated account of the Diesel electric ship, *La Playa*, which will be of direct interest to a very large number of electrical engineers.

Various Items.

Annual Dinner.—The Inst. of the Rubber Industry will hold its second annual dinner and meeting at the Hotel Victoria on Friday, the 16th inst. Tickets for the dinner are 15s. 6d.

Honorary Member.—At a meeting of the Council of the Institution, held on the 1st inst., Colonel Rookes Evelyn Bell Crompton, C.B., Past President, was unanimously elected to be an honorary member of the Institution of Electrical Engineers.

The "Journal of the I.E.E."—We are open to receive offers on behalf of a client for the complete numbers of the *Journal of the Institution of Electrical Engineers*, comprising Vols. 38 (1906-7) to 60 (1922) inclusive. Write ELECTRICITY Office, 36, Maiden Lane, Strand, W.C.2.

The Electro-Harmonic Society.—The next concert (ladies' night) will be held in the Caxton Hall, Westminster (adjoining St. James's Park Station on the Underground Railway), to-night (Friday, the 9th inst.) at 8 o'clock. Chairman, Dr. Alexander Russell, M.A. A really first-class programme has been arranged, and it is to be hoped there will be a record attendance.

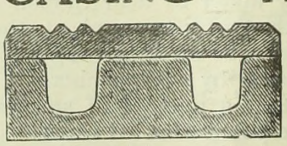
Wimbledon.—Congratulations to Mr. H. Tomlinson Lee on his election to the Wimbledon Town Council at the contest which took place on Thursday, the 1st inst. Mr. Tomlinson Lee contested the largest ward in the borough, and he polled 1,466 votes, as against 993 as polled for Mr. S. B. Stone. It is also satisfactory to know that Mr. Lee topped the polling and polled 307 more votes than any other candidate in the field for any other wards.

I.E.E. Scottish Centre.—The first regular meeting of the session will be held at the rooms, 207, Bath Street, Glasgow, on Tuesday next, the 13th inst., at 7.30 p.m., when the Chairman, Mr. R. B. Mitchell, will deliver his inaugural address. The programme for this centre and also for the Dundee subcentre has been sent to all the members, and contains much matter of direct interest to them, including details of the papers which are due to be read during the forthcoming session.

Plant Wanted.—The Victorian Ry. Commissioners invite tenders for the supply of fibre for insulators for railway work. ——The Municipal Council of Sydney, N.S.W., invites tenders for the supply, erection, etc., of an electrically driven coal unloading and conveying plant at the Council's power-house, Darling Island, Sydney.——The N.S.W. Govt. Rlys. and Trys. invite tenders for the supply of one motor generator set.—— The Finnish Ministry of War at Helsingfors are inviting tenders for 10,000 kilogrammes of hard drawn tinned steel wire for field telephones. Specifications, etc., from D.O.T. (Room 52), 35, Old Queen Street, London, S.W.1.

Meetings.—The next meeting of the Illuminating Engineering Society will be held at the Royal Society of Arts (John Street, Adelphi, London) at 8 p.m. on Tuesday, the 13th inst., when reports on progress during the vacation and developments in lamps and lighting appliances will be presented, and some interesting novelties (the Irwin colour filter system, new types of lighting fittings, motor-car headlights, etc.) will be exhibited. ——The Junior Inst. of Engineers will meet at 39, Victoria St., Westminster, S.W.1, on Friday, the 9th inst. Lecturette, "Amateur Cinematography," by Dr. C. E. K. Mees (slides and demonstrations). Also on Friday, the 16th inst., annual general meeting; and on Friday, the 23rd inst., lecturette, "Technical Arbitrations," by W. A. Tookey, M.I.Mech.E. (Past-Chairman). All at 7.30 p.m.

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ELECTRICITY
A PRACTICAL TRADE JOURNAL

NOVEMBER 16, 1923.

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PRECAUTIONS TO BE OBSERVED IN THE INSTALLATION OF THREE-PHASE A.C. GENERATORS AND TRANSFORMERS.

By D. J. Wilson.

It is thought that in view of the increasing use of 3-phase A.C. plant, that the following tips will be advantageous to electricians in charge of the erection of new installations.

Oil-cooled Transformers.—That there is a fire risk with oil-cooled transformers is not to be denied, and while it is recognised that this is small, it is advisable to install the tranformers in separate fire-proof cubicles, due regard being paid to ventilation and provision made for rapidly draining the oil if necessary.

With the larger sizes, employing a system of oil-cooling other than natural circulation, the cooling arrangement should not be used at light loads, since it is possible to cool the oil below the temperature of the surrounding air, when condensation will take place and the oil will be contaminated with moisture.

The presence of moisture, besides lowering the dielectric strength of the oil, will thicken and decompose it. Now, the presence of 0.01 per cent. of moisture is said to lower the dielectric strength of the oil by about one-third; hence the necessity for periodical testing of samples drawn from the bottom of the tank.

Moisture may be absorbed by the oil during transport, and, when stored, it is therefore very necessary to test before placing in the tank of a transformer, since the presence of moisture is a frequent source of insulation breakdown.

Testing the Oil for Moisture.—A popular workshop test to determine whether or no the oil be dry, is to take a piece of small-bore tube of sufficient length to bottom the receptacle containing the oil, and with the thumb pressed tightly over one end, place the open end into the receptacle until bottom is reached; the thumb is then lifted for a few seconds, after which it is replaced and the tube lifted. The oil within the tube is now emptied into a small vessel and as many samples taken as considered necessary. A piece of $\frac{1}{4}$ in. dia. iron is now heated to a blood red and immersed in the sample oil, when the presence of moisture is indicated by the crackling sound. If no moisture be present the oil will simply puther.

Removing the Moisture.—In the refinery centrifugal machines are used for drying the oil, the water leaving the oil by reason of its superior gravity. The oil is then pumped through a filter press of prepared paper, which allows the oil to pass and absorbs any moisture that may be present. Such a procedure is only possible when dealing with large quantities of oil, although the filter press may be constructed on the site when it is considered that the quantity of oil to be dried warrants it.

Small quantities may be dried by heating, in which case the maximum temperature given by the manufacturers should not be exceeded. With very small transformers the oil can be dried in the transformer tank, the transformer having been first removed.

A temporary brick fire-grate is built, the tank being supported upon short girders or pieces of rail, due regard being paid to the situation in order to avoid particles of moisture entering the tank from the exhaust pipes of neighbouring engines, leaky or sweating roofs and similar sources. Generally speaking, it is advisable to construct a lid which will avoid this, provision being made to allow the moisture to escape. With the larger transformers it is out of the question to attempt to dry the oil in the tank.

Resource is usually made to some temporary tank, to which is fitted a cock for draining purposes. The body of a jubilee tipping truck, or the end ring of a Lancashire-boiler furnace tube, with a plate bolted to the angle-ring to form the bottom, make ideal improvised tanks.

If the works possess a small power-driven pump (electrically-driven for preference) which can be temporarily taken out of its regular commission, then it may be advantageous to connect the suction of this pump to the draining cock of the tank, the delivery being led to the transformer tanks. Failing this, the oil can be run into buckets and man-handled into the transformer tanks. It should be understood that it is not proposed to make an elaborate lay-out for the temporary pumping installation, the pump and prime mover being bolted to planks of convenient length and shored up or weighted, according to its construction and situation.

It is often necessary to dry the oil some few days before it can be utilised. When this is so, great care must be exercised to ensure that the drums or tanks used for storing the oil are scrupulously clean and dry. The drying of the drums may be effected by placing them in some convenient portion of the boiler-room for a few hours.

Drying the Transformer.—The size of the transformer will do much in determining the method of drying, as also will the facilities at hand. Generally speaking, this is done before the oil is placed in the tank.

With small units a bank of carbon filament lamps suspended within the tank will suffice, care being taken that the lamps do not rest upon the insulation of the transformer. It is preferable to hang the lamps well

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down in the tank and to allow for the egress of moisture. Insulation resistance tests should be taken at regular intervals; especially is this so when once the test has begun to rise.

With the larger transformers the lamp method will usually take too much time, and when the facilities permit the following method will give satisfaction. The low-tension side of the transformer is short-circuited by copper bar or cables capable of safely carrying continuously the full-load current. Temporary feeders are now run, via suitable switchgear, from the high-tension side of the transformer to the generator, say, a small stand-by unit. With the generator switch closed, the generator is run up to speed, the current flowing through the transformer being carefully regulated at the exciter panel.

Since the tranformer is not immersed it will not be necessary to exceed the full-load current during the drying operations. The temperature of the windings must be kept under constant observation and the current regulated accordingly.

Drying the Generator.—After erection an insulation resistance test must be taken of the generator windings, and, if this is low, then the generator must be "dried out." There are many ways of doing this, and much depends upon the size of the generator and the material available.

As with small transformers, a bank of carbon filament lamps could be utilised, a box being placed over the whole generator.

If a D.C. generator is available, then the machine may be dried by passing direct current round the windings, the value of the current being regulated according to the temperature of the windings.

With large units, perhaps the best method will be to short-circuit the generator busbars, run up to speed, and carefully regulate the current by means of the exciter rheo.

Whichever method be employed, the temperature of the windings must be kept under constant observation and insulation resistance tests taken at regular intervals and tabulated. When once the test begins to rise it will usually continue to do so at a comparatively rapid rate.

Parallel Operation.—When the generator has to operate in parallel with other generators, additional precautions are necessary.

It is imperative that the phases of the new machine be connected to the corresponding phases of the existing plant when the paralleling switch is closed, otherwise disastrous results will follow. In order to guard against this, the new machine must be phased out before any attempt be made to operate in parallel.

Phasing Out.—It is a grave error to connect a small motor first across the existing busbars and then across the generator bars (using the same notation), and to consider that because the motor revolves in the same direction upon either supply that the phasing out is in order.

A moment's consideration will make this point clear.

If the motor terminals be designated A, B, C and when so connected to the busbars the motor rotates in a counter-clockwise direction, it can be made to rotate clockwise by:—

(1) crossing connections A and C;
(2) or crossing connections A and B;
(3) or crossing connections C and B.

Thus we get clockwise rotation with three different notations.

Now the method is to phase out by means of a bank of lamps across each phase. The lamps may be so connected that they are all dark or all at full brilliance at synchronism, the dark method being the best.

The lamps are series-parallel connected, the sum of their voltage being not less than $1\frac{1}{4}$ times the generator voltage and paralleled in order to guard against breakages. Fig. 1 illustrates the dark lamp method,

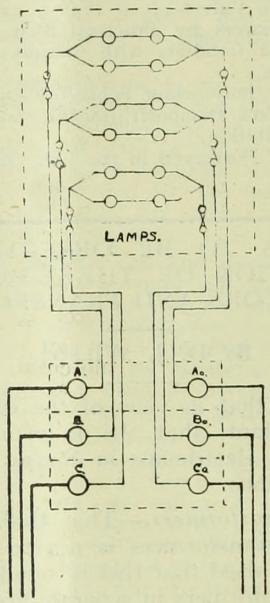


FIG. 1.

the lamps being mounted upon a suitable patrass placed in a convenient position.

When the incoming machine is near synchronism observe if all the lamps flash and darken together; if not, change the generator connections and try again.

At synchronism there is no potential difference between

A and Ao
B and Bo
C and Co

therefore the lamps remain dark.

The lamp method is not sufficiently accurate for every-day synchronising, and is only to be used for phasing out.

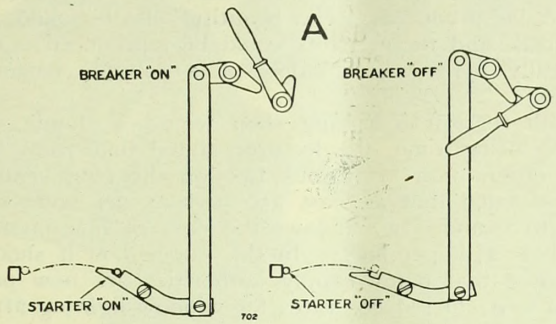
With small units temporary connections may be made and the machine run up to speed, in order to phase out before the permanent connections are made.

Wireless Regulations in Australia.—Wireless telegraphy regulations made by the Governor-General of the Commonwealth of Australia under the Australian Wireless Telegraphy Act, 1905-1919, came into force on August 1, 1923. They deal with the issue of licences for wireless telegraphic or telephonic transmitting and receiving stations, broadcasting, sale of broadcasting apparatus, working of stations, etc. A copy of Statutory Rules, 1923, No. 97, embodying the regulations, may be seen by U.K. firms at the D.O.T., 35, Old Queen Street, London, S.W.1.

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SOME MOTOR-CONTROL PANEL INTERLOCKS.

Industrial motor-control gear having to fulfil many stringent requirements to comply with the Home Office Regulations and the Mining or Factory Acts, it is instructive to study the diagrams, reproduced herewith, which show how mechanical and electrical interlocking is achieved for 2- or 3-phase slip-ring induction motor-control panels. The diagrams are contained in the catalogue which was recently issued by the enterprising



switchgear specialists, George Ellison, of Perry Bar, Birmingham. The panels themselves are combinations of the Ellison "Mill" type circuit-breaker and totally enclosed air-break, air-cooled rotor starters.

The mechanical interlock between breaker and starter is shown in diagram A. The mechanism is simple and not liable to derangement, and acts to return the starter to the "off" position when the circuit-breaker opens.

Of the various electrical interlocks which can be contrived we illustrate six. Electrical interlocking is essential when a perfect mistake-proof gear is desired and when it is required to interlock with other apparatus:—

Arrangement B.—Two contactors are fitted to the breaker and one contactor to the starter, and are connected in series with the no-volt coil to the live side of the breaker. A hook actuated by the no-volt plunger engages with a detent on the breaker handle shaft when the no-volt coil is not energised and disengages when the coil is energised. The coil circuit is completed by returning the starter handle to "off" and moving the breaker handle till the breaker contactors touch.

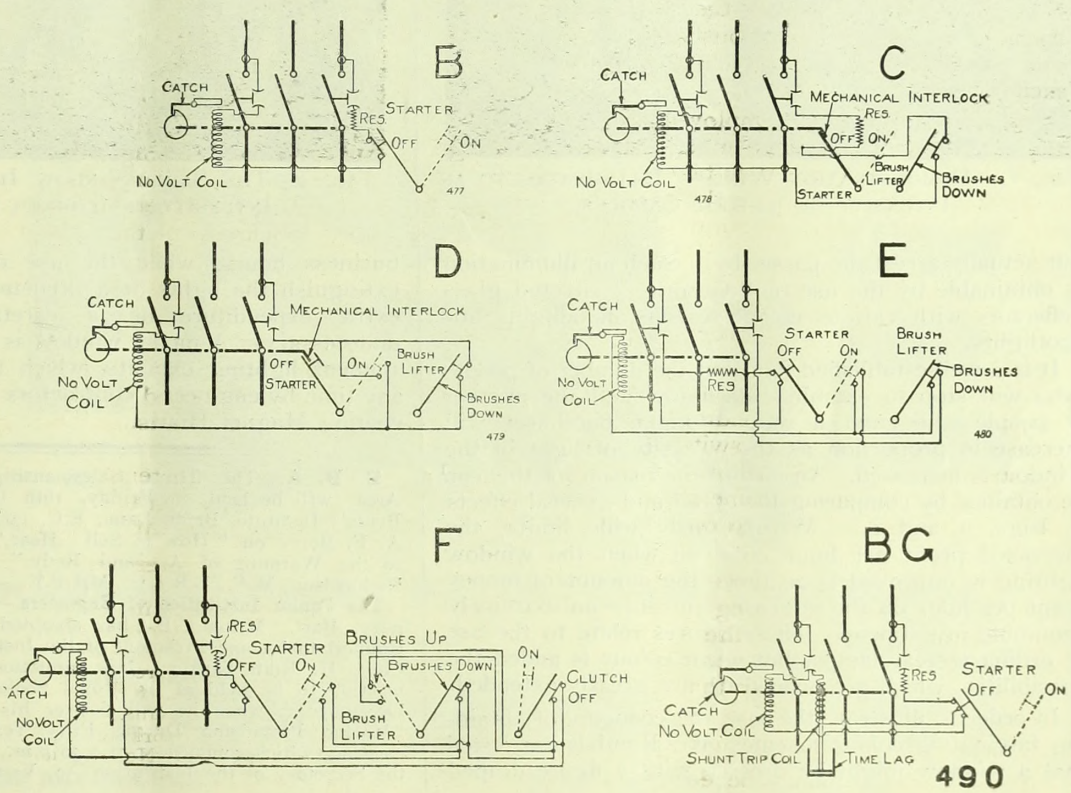
Arrangement C.—This is a combination of the mechanical and electrical interlocks to lock a third piece of apparatus such as the brush-lifting gear of a slip-ring motor. The single pole limit switch, List 301, is suitable as the contactor on the brush gear. It ensures that the brush gear and starter are in correct positions at starting, but it is not "correct sequence."

Arrangement D.—This is an extension of C to provide correct sequence. It compels the operator to put the starter and brush gear in the correct positions at starting, and to bring the starter to the "full on" position before operating the brush gear, but it does not compel him to operate the gear.

Arrangement E.—This is a complete electrical interlock to effect the same purpose as D.

Arrangement F.—This is an extension of E to a fourth piece of apparatus such as a clutch, and shows how any number may be interlocked to ensure correct sequence.

Arrangement G (lettered B G in the diagram).—There is nothing in the foregoing interlocks to compel the operator to complete the series of operations; in F, for example, he may operate the starter but leave the brushes "on" and the clutch "off." The device G ensures that the whole of the operations are performed in a predetermined time, and if connected to the last of the series it ensures that the whole must be completed, and thus constitutes a "Complete Cycle" device. The breaker opens if the cycle is left incomplete; the time is adjustable and the device may be sealed, and may be an addition to interlock B, C, D, E or F. It is, of course, necessary to use a breaker with the no-volt feature, and fitted with an extra shunt trip coil.



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MODERN WINDOW LIGHTING.

After a short opening speech by Mr. J. Y. Fletcher, a director of the G.E.C., an interesting paper on the value of shop window illumination was given by Mr. E. L. Randall, of the Illuminating Eng. Dept. of the General Electric Co., Ltd., before the British Assocn. of Display Men at Magnet House, Kingsway, on the 25th ult.

After pointing out that a well-lighted shop window is one of the most vital factors in business-getting machinery, Mr. Randall reminds us that co-operation between merchant and artist has resulted in shop-window display reaching its present high standard in artistic expression, credit for this being largely due to the incessant activities of the British Association of Display Men. For nearly six months in the year, however, windows are entirely dependent upon artificial illumination for 30 per cent. at least of their effective day. A perfect window illumination does not merely consist of sufficient and glareless light. It must be of such a nature that the artist is given a fresh means of expression which will not merely attract

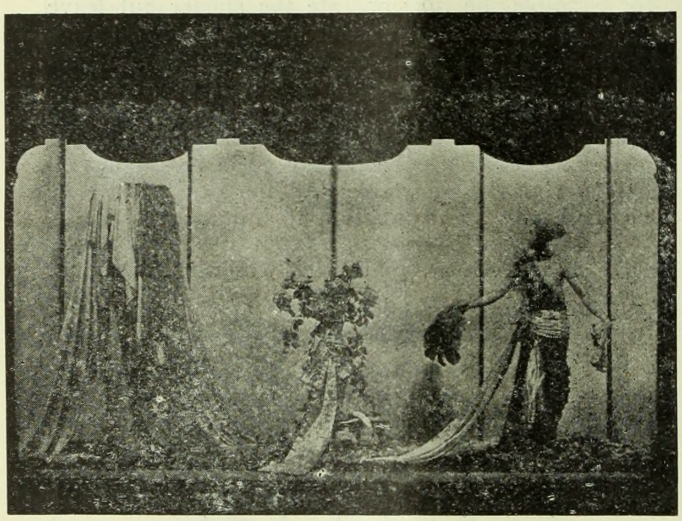


FIG. 1.—DEMONSTRATION WINDOW ILLUMINATED TO AN INTENSITY OF 30-FOOT CANDLES.

but actually arrest the passer-by. Such an illumination is obtainable by the use of "Gecoray" silvered glass reflectors with various colour screens, floodlights and spotlights.

It is a well-established fact that the number of people who will stop to examine a window and the number of people who enter a shop to make purchases will increase in proportion as the intensity of light in the window is increased. An idea of the reason for this can be obtained by comparing the detail and general effects in Figs. 1 and 2. Within fairly wide limits, the increased profit per hour obtained when the window lighting is improved is 20 times the amount of money spent per hour on the increased current—an extremely profitable investment. These figures relate to the use of ordinary clear lamps, but when colour is added the possibilities which are opened up are greatly extended.

In order to illustrate the ease and economy of obtaining fascinating colour schemes, Mr. Randall suggested that a window might be dressed with a figure draped in white material and illuminated by means of red and blue coloured screens to give a general mauve tone. The draperies on the figure would naturally assume the tone of the general lighting, and appear no longer white but mauve. When spotlights with clear lamps, fitted at each end of the window, were trained on to this figure the dress would instantly change to white, but the shadows would remain illuminated by the mauve light. By switching off first the red lamps (when the shadows would be changed to blue), and then changing over from the blue lamps to the red (when red shadows would be produced), very beautiful effects could be obtained, and these effects could be reproduced automatically by the installation of a suitable flashing device.

With regard to leaving shop windows illuminated after closing time, the lecturer stated that from his own observation in various London shopping centres he estimated that at least 250 persons per hour will stop to examine a window the cost of illuminating which is 2¼d. per hour. In this connection it should be noted that many supply authorities are now prepared to grant reduced rates for window lighting after

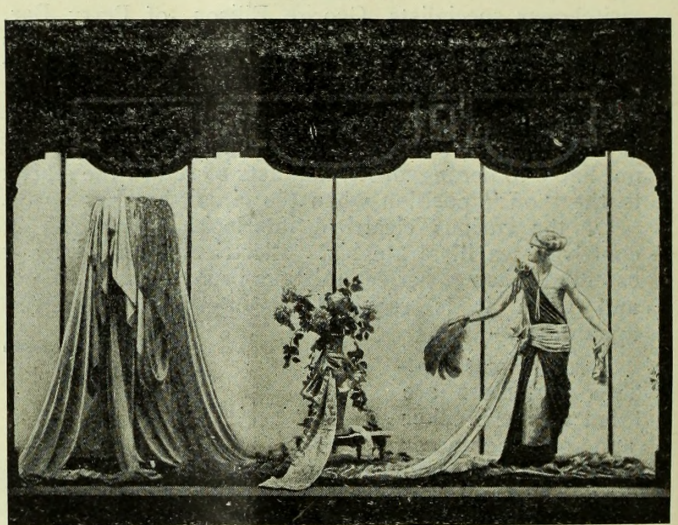


FIG. 2.—THE SAME WINDOW ILLUMINATED TO AN INTENSITY OF 100-FOOT CANDLES.

business hours, while the use of a time-switch to extinguish the lights at a predetermined time renders extra expenditure on a caretaker or attendant unnecessary. A model window is included in the permanent lighting exhibits, which may be inspected at any time by engineers, contractors and their customers visiting Magnet House.

E. D. A.—The Third Salesmanship Conference, London Area, will be held on Friday, 16th inst., at 7.30 p.m., St Bride's Institute, Bride Lane, E.C. (*3rd floor*). Paper by Mr. A. F. Berry on "How to Sell 'Heat,' and Problems Related to the Warming of Air and Body." Chairman: Major H Richardson, M.C., F.R.S.E., M.I.E.E.

The Junior Institution of Engineers.—Sir J. Fortescue Flannery, Bart., M.Inst.C.E., has accepted the invitation of the Council to become President of the Institution in succession to Capt. H. Riall Sankey. His induction will take place at a meeting to be held at the Royal Society of Arts on Friday, December 7, when he will deliver his presidential address—"Marine Propulsion During Fifty Years." Tickets for the meeting, which commences at 7.30 p.m., may be obtained from the Secretary of the Institution, 39, Victoria Street.

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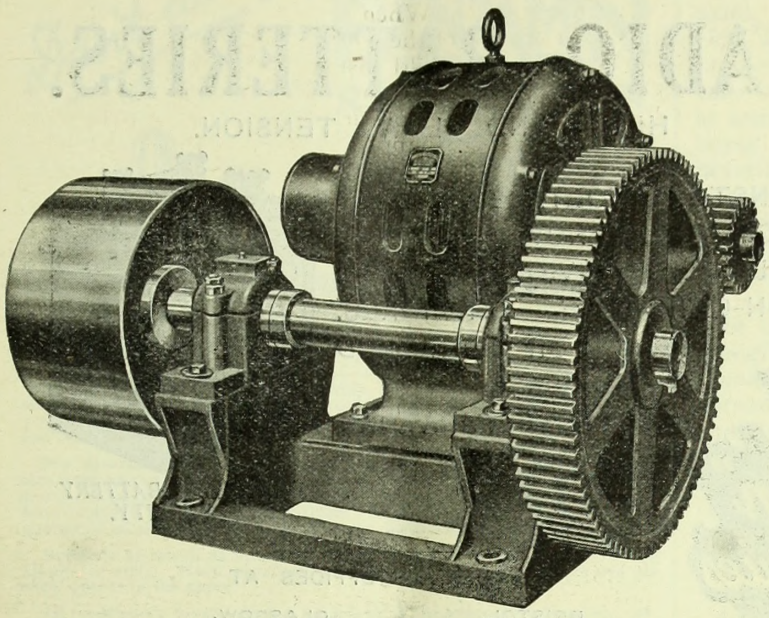


Illustration shows a 40 B.H.P. Standard Back-gear Motor.

NOTE the Robust design maintained throughout.

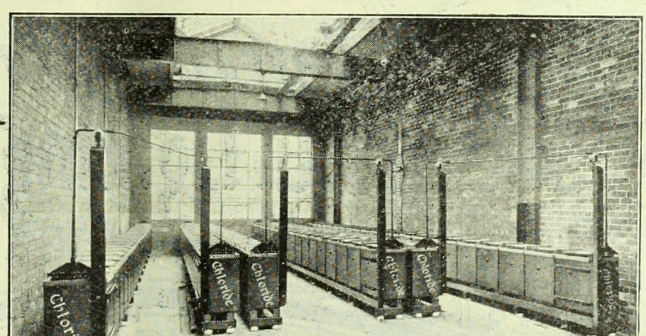
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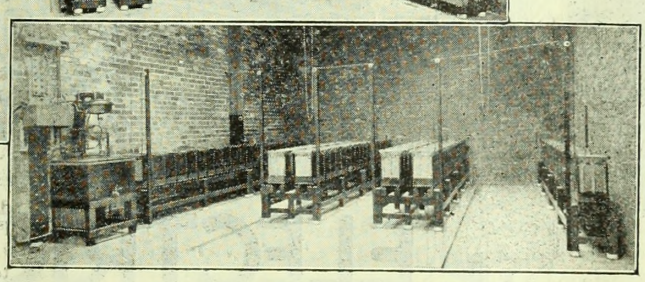
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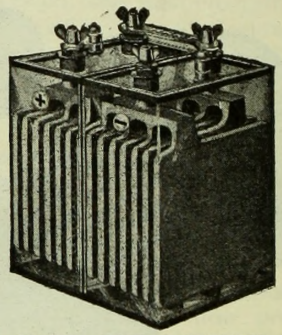
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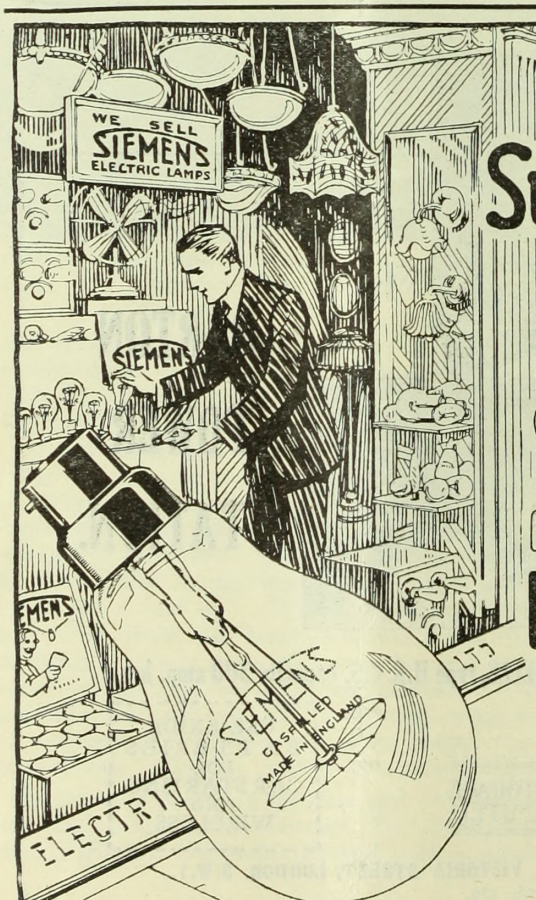


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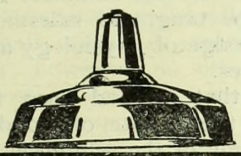
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TO OUR READERS.

ELECTRICITY is published every Friday, and, if ordered, is on sale at the principal Railway Station Bookstalls and Newsagents on that day. It has a very large sale throughout the United Kingdom, as well as in the British Colonies and Abroad.

New advertisements for the displayed columns and alterations to existing ones must reach the publishing office not later than first post Tuesday morning, in order to be in time for the issue of the following Friday. This is important. Rate quoted on application. Subscription : 13s. a year, 6s. 6d. half-year, 3s. 3d. a quarter in advance, postage prepaid in the United Kingdom and abroad.

Questions to which an answer is required must be accompanied by a 1½d stamp for reply. When considered of sufficient interest, the answer will probably appear in the paper.

All remittances payable to the Publishers, S. RENTELL AND CO., LTD., 36-39, Maiden Lane, London W.C. 2. Telephone No. 2460 Gerrard.

Current Topics.

A Fine Show.

The outstanding electrical event of the current week is undoubtedly the All-British Wireless Exhibition and Convention which is being held at the White City, Shepherd's Bush. Jointly organised by the National Association of Radio Manufacturers and Messrs. Bertram Day, this Exhibition is the second one of its kind to be held in London, and a run round the many stands brings home to the visitor the many marked improvements in design and refinements of detail and finish which have been introduced in the course of a brief twelve months since the first Exhibition closed its doors at the Horticultural Hall.

The growth of the industry during the same period is evident from the fact that it would have been physically impossible to accommodate the present exhibits in the somewhat limited confines of the Horticultural Hall, and by 1924 it may be necessary to find an even more commodious venue than Hall C. at Shepherd's Bush, which is already filled to repletion with interesting and attractive exhibits. The final solution of the Licensing problem, and publication of the long-awaited report has unquestionably reawakened public interest in Broadcasting, and, judging from the popularity of the Exhibition up to the time of writing, there is quite another trade boom in being. Exhibitors generally report good business, and the crowds, on Saturday especially, bear evidence in support.

This is not the place for a detailed description of the exhibits, but one or two general remarks will serve to indicate the apparent trend of design. Due, no doubt, to the new "Constructor's" Licence, components have received a good deal of attention from designers and manufacturers, and there are quite a number of novel and interesting fitments which will make an undoubted appeal to those ingenious and energetic individuals who find pleasure and profit in assembling their own wireless sets. On the other hand, the claims of the more fortunate buyer, able to pick and choose his own elaborate outfit, regardless of cost, have not been overlooked, and there are some very fine specimens of "wireless furniture" on view at many stands. In this connection, it is well for both buyer and trader to remember that a highly ornate or beautifully finished cabinet does not necessarily house an efficient listening-in set, and the cognoscenti will be well advised to study electrical, mechanical, wiring, and lay-out details before devoting any attention whatever to the shell which encloses it.

In this connection we noticed an exceptionally well thought-out set of the "Rolls-Royce" order, on Stand 84. It is a super-seven (valve) Jacobean cabinet bureau, wtih enclosed loud speaker, and is generally pronounced by those competent to judge of "wireless efficiency" as the pick of the bunch. We hope to publish details of this set at a later date. It is a veritable triumph of brains and engineering, and is accommodated in a neat and well finished oak cabinet with sloping top.

In the complexities of wireless telephone receiving sets the importance of clean, well executed, and accessible wiring is frequently overlooked. As a matter of fact the actual wiring of a set is one of its most vitally important features, and many an otherwise excellent combination has been totally ruined through lack of appreciation of this obvious fact. Capacity and inductance play such important parts in broadcast reception, that every turn or bend in the course of a point-to-point connection has its influence on the ultimate results obtained from the finished set, as has also the too close proximity and resultant capacity between wires running approximately parallel for quite short distances. These are points often totally disregarded by the otherwise careful home constructor, and even by the better known manufacturers of complete sets.

In headphones and loud speakers there is nothing very startling or revolutionary on show, but the products of the leading telephone manufacturers show a marked improvement over last year's standards. The popular Claritone Loud Speaker is to be seen on a good many of the stands, and this year has its complement in the Claritone Headphone, a very excellent production by the same manufacturers, and yielding highly efficient results on actual reception. These headphones cost no more than the other standard British makes, and are certainly good value. We saw a letter from a well-known maker of sets announcing that he had thoroughly tested these headphones, and was so well satisfied with the result that he had decided to adopt them as his standard for this season's trade.

One of the most interesting features of the valve section is a new model, with an extremely low filament current consumption, which promises to overcome the accumulator bugbear. In this connection the tremendous popularity of listening-in is bringing out very strikingly the fallibility of the small storage battery, and, incidentally, the unreliability of charging

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stations, garages, etc. With all battery operated electrical apparatus the accumulator is almost invariably the fly in the ointment. A vital source of supply of the essential "juice," it is prone to giving out at the most inopportune times, sulphating, fuming, leaking, spoiling carpets, etc., and generally constituting a chronic electrical nuisance.

Oh, for a certain remedy from this weakness in our manifold ingenious electrical schemes. The "Battery Bogie" is a very real one, and in wireless, not only the L.T. but also the H.T. bogies are always with us. One cannot altogether blame the battery makers; they do their best, but the fates, and fundamental principals are against them. Accumulators for H.T. are a case of "out of the frying pan into the fire," for the simple reason that what suits any storage battery best is hard work and plenty of it, in the shape of regular charge and discharge. This is just what the H.T. storage batteries in the main will *not* get, and I predict a very brief popularity for this class, although the alternative to frequent and costly renewals of dry-cell sections is at first sight attractive. The whole trouble lies in the placing of these comparatively delicate accessories in the sole charge of a layman user who does not appreciate the care and attention essential to their continued well-being. ELEKTRON.

ENGINEERING TRAINING.*

On Monday, November 5, Mr. A. F. Harmer was in the chair at the opening meeting of the informal section of the I.E.E., when the president, Dr. A. Russell, opened a discussion on "Engineering Training." He said it was agreed that a student's training should be practical and theoretical, but the difficulty was to determine how long each should last. Twenty years ago this was a favourite topic for discussion in schools, especially in Germany, where they adopted the system of a high standard of general training, afterwards specialised into sections; but the defect of systems is that they are apt to ignore the human factor.

It is very important in the national interest that some of the best boys be attracted into the engineering side. The public schools aim generally at scholarships and letters, because successes here reflect glory on the school. Engineering success should be equally glorious.

The idea of raising the status of the profession by stiffening the examinations is wrong. Clever boys are often eccentric and unable to pass examinations creditably, and he hoped someone in the discussion would suggest an alternative to examinations.

Lieut.-Colonel W. A. J. O'Meara thought the engineering profession had not attained the status it deserves, largely because anyone may term himself an engineer. In many foreign countries this is not allowed.

Mr. P. M. Baker had a collection of lantern slides showing views of training-school workshops in India and in England. He advocated that workshop training should follow as closely as possible the actual routine of business, so that students clock-on and clock-off and produce against cost rates. On the question of examinations, the Indian can beat the European very easily by his ability to memorise whole volumes of principles and data.

Professor C. L. Fortescue called attention to the remarkable sectionalisation of engineering in the past few years. We have administrators, research men, production men, salesmen, draughtsmen, and a few designers. He thought that some of the claims made for the field of the research man almost eliminate the engineer. Psychology should be taught to salesmen, and to production men a knowledge of physiology and the muscular powers of operatives.

Dr. R. M. Walmsley said that he had been for eighteen years connected with the Senate of London University, and in regard to some of the references to examinations he could not divest himself of responsibility, but the evils of examinations, as well as their inevitableness, were recognised, and the tendency is to modify them. He regarded engineering training as consisting of fundamentals that all engineers must know, whether they be designers, production men or salesmen.

Dr. F. T. Chapman said that many forms of training produce good results, but the old system of five years' apprenticeship is no longer held to be adequate. A very successful method for training one grade of engineer was apprenticeship combined with eight hours' or so of day school training per week. Long periods of bench and lathe training are not essential for higher grade engineers.

Mr. W. Day wondered whether the aim of training sometimes was to produce a certain degree of mental nimbleness instead of mental tools. He said the acid test of an engineer must always be what can he *do*, not what does he *know*. The employer requires of his men character, capacity for work, energy and intelligence, none of which academic honours guarantee.

Mr. A. W. Berry and Major T. Rich spoke of French practice.

Mr. L. W. Phillips also spoke and Dr. Russell summed up the points raised and concluded a debate of considerable interest.

* Précis of discussion at the I.E.E. Informal meeting on November 5.

EVERSHED'S WIRELESS GENERATOR.

It has been brought to our notice that in the description of this machine appearing in our issue dated November 2, there is a statement which might be somewhat misleading. This is the reference in parenthesis to the actual output curves shown in Fig. 1, which appears at the top of column 2, page 594. These curves are output curves in milliamperes, and are quite distinct from the large number of curves which were plotted experimentally for the determination of the amount of ripple. They (i.e., the curves shown in Fig. 1) were plotted with the aid of a milliammeter and voltmeter, whilst the Joubert ring was used for the ripple curves.

Birmingham.—At the B'ham and District Electric Club on Friday, October 26, a paper was read by Mr. Henry Joseph, A.M.I.E.E., on "Electric Motors in Service," in which the lecturer dealt with the installation of motors, the various methods of transmission of power, and the causes of breakdown. There was in the paper a considerable amount of criticism of the design of modern motors, and the author suggested that the craze for mere cheapness in small motors had seriously militated against reliability. Much sound and valuable advice was given in connection with the installation and maintenance of motors in industrial use.

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NEW B.T.-H. RADIO VALVES.

Until recently the great drawback attendant upon the use of valves in wireless receiving has been the necessity of having accumulators to heat the filaments. Considering the extremely small amount of energy in the electron stream liberated from a filament, compared with the energy delivered to the same filament by the heating battery (usually between one-half and two-and-a-half watts), it seems a very inefficient process. So far, however, no other method capable of use on a practical scale appears to have been found by which we can expel from a cathode a sufficient number of electrons per second to give us a working current.

For the same temperature, however, bodies vary widely in the number of electrons emitted per second. Tungsten, a refractory metal widely used for filaments, will emit about 0.3 amp. per sq. cm. at a temperature of 2,500 deg. absolute. This is far exceeded by thorium, however, from which at a lower temperature the emission is many thousandfold that of tungsten. This fact is made use of by The British Thomson-Houston Co., Ltd., in the production of their type B.5 valve, which is now being manufactured at the Rugby Works. A process applied to the tungsten filament enables a layer of thorium to be deposited on

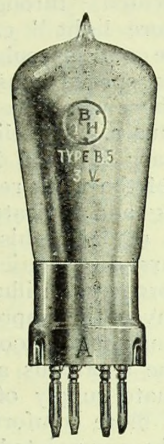


FIG. 1.

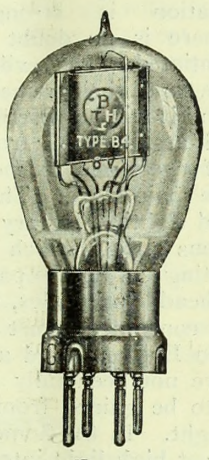


FIG. 2.

the surface and its great emitting properties utilised. The result is a valve requiring but one-fifteenth of the wattage to heat its filament that is required by what is generally known as the "R" valve. The latter requires about 2.6 watts heating energy, i.e., about 0.65 amp. at 4 volts. The new B.5 valve, however, requires but 0.18 watt, or 0.06 amp. at 3 volts, and requires, therefore, only a dry battery to operate it. While taking this exceedingly small filament energy, the B.5 valve is an improvement over the average "R" valve as regards the important constants of voltage amplification factor and anode resistance. As a detector, when used with 20 to 40 volts anode, and as an amplifier with 40 to 80 volts, it gives excellent service.

Another new receiving valve of larger size and power than the above is known as the B.4. Its filament consumes 0.25 amp. at 6 volts. This valve is designed so as to have low anode resistance and high amplification factor. It gives excellent results both as detector and amplifier, but is particularly suitable for use in all sizes of amplifiers, especially those used with the largest size of loud speaker. An anode voltage up to 100 is satisfactory. It is advisable to use this valve with a grid biasing voltage of minus 4 or 5, when the plate voltage is at the maximum of 100. This ensures operation at a suitable point on the characteristic curve, giving freedom from distortion.

Questions and Answers by Practical Men.

RULES.

QUESTIONS: *We invite our readers to send us questions, preferably on technical problems that have arisen in actual practice. Questions which we consider of sufficient interest to our readers will either be replied to under "Answers to Correspondents" or replies will be invited from our readers. One shilling will be paid for the question which we select for competitive replies in this column.*

ANSWERS: *A fee of 10s. will be paid for the answer which we consider shows the greatest merit, and 5s. for the one we select as second best. In judging the replies, importance will be attached to clearness and conciseness, as well as accuracy. The Editor reserves the right to make no award, or to accept only one reply, if, in his opinion, the answers received do not possess sufficient merit. Competitors desiring the return of their manuscripts, if unaccepted, should enclose stamped addressed envelope.*

Write on one side of the paper only, and if diagrams are sent, draw them on a separate sheet of paper attached to the manuscript. Competitors may adopt a "nom de plume," but, both in the case of questions and answers, the competitor's real name and address must be sent with the manuscript as a guarantee of good faith. No correspondence will be entered into with regard to successful replies. The Editor's decision is final.

Commencing with Question No. 101, a Diploma of Merit will be awarded to the six competitors who win the first or second prize the most times during the next twelve months.

The words "Questions and Answers" or "Q" and "A" should be placed at the top left-hand corner of all letters intended for this column.

QUESTION NO. 171.

I have a 10 h.p. motor and the cone insulation on the vee rings has given out. How can I build this up again?—"A. C. WARNER."

QUESTION NO. 172.

Can any reader give working details of the method of producing power by means of motor generators for motion picture work? I require 75 amperes at 75 volts.—"CINEMA OPERATOR."

(Replies to Questions Nos. 171 and 172 must be received not later than December 1, 1923).

"GECOFIX."

Under the brand "Gecofix," the General Electric Co., Ltd., are now placing on the market a complete range of domestic electric light fittings to meet a demand which now exists for fittings, which, whilst retaining the scientific characteristics and general excellence of more expensive designs, shall be moderate in price in order to bring them within the reach of those living in small houses and flats.

A new catalogue, No. F. 3,132, has just been issued, in which these fittings are fully described and illustrated. We are informed that every item is manufactured by the same craftsmen and designed by the same artists who are responsible for the production of the company's more elaborate and expensive electric light fittings.

The range includes pendants, hall lanterns, semi-indirect fittings, dining-room pendants, dressing-table pendants, brackets and electroliers, together with a selection of artistic table standards, silk shades, and ornamental glassware.

An interesting innovation is the scheme whereby three standard selections, consisting of six units, one for each of the principal rooms in a house, can be obtained as a complete outfit. Full particulars of these outfits are given in a series of small folders, which, we understand, are available for overprinting with dealers' names and addresses.

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"FISHING" INTERIOR CONDUITS WITH COMPRESSED AIR.*

An ingenious substitute for the present method of "fishing" interior conduits by hand with a wire has been found by John T. Myers, a Buffalo, N.Y., wireman, who has invented a machine to do the work by compressed air.

The necessity for something different in the line of fishing interior conduits came up about the time the installation department of the New York Telephone Co. started work of installing the telephone system in the new Hotel Statler, at Buffalo. The old method of fishing conduits with the flat steel fish tape was considered too slow for such a big job.

The apparatus consists of one compressed air tank, capable of sustaining 300 pounds test and 150 pounds working pressure, and 1¼ h.p., 110-volt motor heavy duty, belted to a four-cylinder air pump mounted on four wheels and enclosed with sheet iron, with top cover hinged. A check valve was installed between the pump and air tank to maintain tank pressure. A gauge was installed on the tank for recording the air pressure in pounds.

About 75 pounds pressure was used for blowing and fishing the conduits. A relief or safety valve was installed on the tank for "Safety First," so as to prevent any over-compression in the tank, together with the necessary hose connections for carrying the compressed air to the conduits. This hose was approximately 25 feet long. The method of "fishing" the conduit was as follows :—

First the conduits were blown out. In all cases every conduit was blown clear and clean. Second, after the conduits were blown out, they were then "fished," with the fish line left in as a pull-in line. These lines were re-used. The line was fed through a small hole in the back of a 90-degree nipple, the same size as conduit, slightly tapered at the end, allowing the line to run through and out the nozzle end. Any suitable waste material or "mouse" was fastened on the fish line and inserted in the conduit.

By means of a lever valve located back of the nozzle, air was released which forced the "mouse" on the fish line through the conduit. This method proved so successful that two men could "clean" and "fish" an entire floor consisting of 79 rooms in two days. They were also saved a long, laborious job, time and money. The approximate cost of this blower equipment was less than £10 for material—most of it second-hand, plus one man's time for one week. This blower can be used for cleaning out motors and generator armatures, field coils, etc.

A Pleasing Gift.—Messrs. Burndept, Ltd., have just recently presented a complete wireless receiving set to the wireless section of the South African Inst. of Electrical Engineers. It was received with much appreciation.

West Riding (Aire and Calder) Electricity District.—The Electricity Commissioners give notice that they intend to hold a local inquiry in the Council Chamber, Town Hall, Bradford, on Tuesday, December 4, 1923, at 10.30 a.m., and following days, if necessary, with reference to this scheme, and in order finally to determine the area of the proposed district.

**Telephony* (Chicago.)

Reviews of Books, &c.

[Books noticed in this column will be sent from ELECTRICITY *Office to any part of the world, for the published price, plus five per cent. for postage (minimum 2d.), and orders will be appreciated.]*

STANDARD LIGHTING. By H. C. Cushing, Jr. (New York and London. Rentell, 15s. net.)—This book is compiled by a staff of experts and is endorsed by the Lighting Department of the Joint Committee for Business Development in the movement to "Electrify," and by the Society for Electrical Development. In the preparation of the text the aim has been to present information of real practical value to both purchaser and the installer of lighting equipment. Such experts as S. E. Doane, G. H. Stickney, D. W. Atwater, Ward Harrison, H. H. Magdsick, J. R. Colville and M. Luckiesh have contributed to its pages, and it may be said that it will supply a long-felt want in the illuminating engineering profession. Illumination fundamentals are adequately dealt with in one section of this work, and other sections deal very fully with Illumination Design Data, Store and Show Window Lighting, Industrial Lighting, School Lighting, etc. The necessity for better illumination is strongly advocated throughout, and there is no doubt that "more light" can be substantiated. The evils of glare and specular reflection, and their remedy, receive special consideration, and it will be appreciated by those who have been, and still are, suffering from these causes. The elimination of eye-strain is most necessary if good health is to be maintained. The section of the work relating to flood lighting is very interesting and indicates the enormous strides which have been made in this class of lighting during the past few years. In America, the "go ahead" principles, as far as progress in illumination is concerned, must surely convey the impression to us in England (and a correct impression, too) that we have not been fully alive to the enormous advantages to be gained from an adequate supply of artificial light. In the home it means more comfort. In the street high light intensity can be appreciated since it is not only "the silent policeman," but it is a sure guard against accidents. In the factory, more light and better light means less spoilage and better conditions for the worker. Mr. Cushing has accomplished the object for which the book was written, and we feel sure that it will have a good sale.

REPORT OF THE COMMITTEE OF THE PRIVY COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH, FOR THE YEAR 1922-23 (Cmd. 1937). Royal 8vo; Paper wpr; pp. iv + 141; one plate. (H.M. Stationery Office. 4s. net. By post, 4s. 2d.)—This publication, which is the Eighth Annual Report of the Committee of Council, gives an account of the work of the Research Department during the year ended July 31, 1923. The report is divided into the following main sections :—

Report of the Committee of Council.
Report of the Advisory Council.
Summary of the Work of the Research Boards and Committees of the Department.

The report is supplemented by appendices giving (1) particulars of the Research Boards and Committees of

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the Department, (2) statistics of grants made to individuals, (3) lists of aided researches, 1922-23, (4) a list of publications by individuals in receipt of grants, (5) an account of developments in the organisation of research in India, Egypt, and the Overseas Dominions, (6) information concerning Research Associations, (7) the enactment of the French Legislature and official decree relative to the establishment of the French Research Department, and (8) a list of Departmental publications. An index is added.

THE REGENT STREET POLYTECHNIC SCHOOL OF ENGINEERING AT THE B.T.-H. CO.'S DEMONSTRATION ROOMS.

On the 5th inst., the third year students in Electrical Engineering of the Regent Street Polytechnic School of Engineering attended an industrial and domestic lighting demonstration at the British Thomson-Houston Co.'s Demonstration Rooms, 15, Savoy Street, Strand. The party were conducted by Mr. Philip Kemp, M.Sc., M.I.E.E. Mr. W. Millner, B.Sc., A.M.I.E.E., Illuminating Engineer of the British Thomson-Houston Co., demonstrated various industrial lighting effects, commencing with obsolete local lighting, consisting of carbon filament lamps and enamelled iron shades (unfortunately a replica of the system still in use in many industries), and concluding with the design of the ideal system of illumination in which glare is conspicuous by its absence, and the light is perfectly diffused. The demonstration was very much appreciated by the visitors, who, although perfectly well aware of the progress made during recent years in the efficiency of the modern gasfilled lamp, were greatly interested in its application to industry. Domestic lighting effects were also demonstrated, the decorative and charming effects produced by artistic designs upon glassware and silk-covered shades being appreciated.

THE WIRELESS EXHIBITION.

It is hardly necessary to state that the Wireless Exhibition now open at the White City, Shepherd's Bush, is the greatest Wireless Exhibition so far organised in this country. A recent development is the fact that it is being held, for the first time, in conjunction with the National Association of Radio Manufacturers. As there are nearly one hundred exhibitors, including practically every manufacturer of note, it is impossible for us to deal at all adequately with the exhibits, which naturally portray the latest and most up-to-date equipment now offered to the public.

The following are some of the exhibitors:—Ashley Wireless Telephone Co., Ltd. (69, Renshaw Street, Liverpool), who include a full range of their "Claritone" appliances in their very complete display. As expected, such firms as the British Thomson-Houston Co., Ltd., General Electric Co., Ltd., Siemens Bros and Co., Ltd., the Sterling Telephone and Electric Co., Ltd., and the Western Electric Co., Ltd., have spared no effort to make their stands thoroughly attractive. A feature of the display of the Metropolitan-Vickers Electrical Co., Ltd., including "Cosmos" sets of all sizes, is their new Radiobrix range of units, uniform in size and design, with which a variety of circuits and receiving sets can be built up simply by connecting together the units in various combinations. The Igranic Electric Co., Ltd. (149, Queen Victoria Street, E.C.4), are displaying their many well-known accessories, while Hazeltine Neutrodyne Radio Sets, Ltd., of the same address, show their receiving sets, loud speakers, and frame aerials. All kinds of accumulators for wireless are shown by the Chloride Electrical Storage Co., Ltd., the Hart Accumulator Co., Ltd., and others, while various dry and other cells may be inspected. The Edison-Swan Electric Co., Ltd., are showing a complete range of receiving sets, and practically every necessity, including, of course, "Ediswan" valves of all types. In this connection it is interesting to note that the first valves to be made either in this country or any other were made at the Ediswan Works at Ponders End. A very handy Ediswan wireless catalogue has just been issued.

The Marconi stands and the daily Broadcast concerts in the B.B.C. Demonstration Hall, the stage being a replica of that at 2LO Savoy Hill, W.C.2, are a very attractive feature of the Exhibition, which should be visited by all interested in wireless before the closing date, November 21.

ELECTRICAL PROGRESS PORTRAYED IN THE LORD MAYOR'S SHOW.

The Lord Mayor's Show this year was largely devoted to representing the progress of British Industry Across the Ages, the Electrical Industry being represented by a car provided by the British Electrical Development Association.

In view of the difficulty in dealing with so large a subject, and particularly of using attractive lighting schemes in the daytime, it was decided to put up a representation of a modern electrical development of the greatest use and interest to everyone, and not yet so well known by the general public as many other methods of employing electrical energy.

The car represented briefly the progress of the art of cookery, showing, in comparison with the early methods of preparing food with the crudest implements over an open fire, the modern and rapidly developing use of electricity in the kitchen. The electric cooker, which was in operation during the progress of the car along the route, was supplied with energy from a battery carried upon the vehicle, which was an electric one driven by an Ironclad Exide standard vehicle battery. The car was loaned by the Metropolitan Borough of Hackney, to whom the E.D.A. wish to acknowledge the kind and prompt assistance received in getting this display together at short notice through Mr. L. L. Robinson and his staff. Also to the Chloride Electrical Storage Co., Ltd., for the loan of battery; and the British Electric Transformer Co., Ltd., for adapting a Hackney cooker to the voltage available, and for the assistance of a demonstrator.

Dutch East Indies.—According to the report of the British Commercial Agent in Batavia, as printed in the current issue of the *Board of Trade Journal*, there is now a particularly good demand for electric fittings, while the surplus stock of all engineering lines is being consumed, so that an improvement in the engineering trade may be expected before the end of the year.

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Trade Notes.

"**Twentieth Century Advertising,**" edited by Mr. J. Murray Allison, is a splendid production which will appeal to all publicity experts and advertising managers, as it contains a large amount of information of direct interest to such readers. The price is 2s. 6d. per issue, and the publishing offices are at Bush House, Aldwych, London, W.C.2.

Hammer Drills Circular No. 89 has been issued by the **Consolidated Pneumatic Tool Co., Ltd.**, of 170, Piccadilly, London, W.1. It describes the latest types of pneumatic hammers and air-compressor plants, and should therefore be of interest to road-making engineers and others.

From the **Sun Electrical Co., Ltd.**, of 118, Charing Cross Road, London, W.C.2, we have received a neat 12-pp. catalogue of Brascolite electric-light fittings, for which there should be a good market in the electrical trade.

Electros of the **E.D.A.** three prize slogans can now be obtained from the offices at 15, Savoy Street, Strand, price 5s. each, and it is suggested that they would act as excellent advertisements of electricity on the ordinary trade envelopes. It is to be hoped that full advantage will be taken of this suggestion, because there is no doubt that envelopes with effective printing thereon do attract attention, and it is of course up to us all to do our best to develop the electrical trade in every way possible.

A leaflet from the **Hart Accumulator Co., Ltd.** (Stratford, E.15), gives price and essential particulars of "Hart" starter batteries for Morris cars. We note that these batteries have high capacity, low internal resistance, and give a steady voltage.

The **Midland Electric Manufacturing Co., Ltd.** (Barford Street, Birmingham), have just issued a new illustrated catalogue of their well-known ironclad switch and fuse gear. In the 56 pages of the list is given a full account of the design and construction of M.E.M. specialities, together with a great deal of information and many pages of tables useful to the installation engineer. For the electrical wholesaler selling points are carefully detailed, so as to simplify the work of the salesman as much as possible. Many new designs are shown, and prices have been reduced. Copies will be sent to trade buyers on application.

An excellent catalogue of steam and electric cranes has been issued by the **Bedford Engineering Co.**, of Bedford. It contains a well-illustrated description of the various types manufactured by the company, and should therefore be of direct interest to central-station engineers and electrical manufacturers generally, to whom it will be willingly sent on receipt of proper official application.

Various Items.

Inst. of Engineering Inspection.—An interesting programme of the work of the session 1923-4 has been issued by the Secretary of the Inst. of Engineering Inspection, Palace Chambers, Westminster, London, S.W.1. We notice that on Monday next, the 19th inst., there will be a reception and dance at the Hyde Park Hotel; on Thursday, the 22nd inst., a morning visit to Lotts Road Power Station; and on Wednesday, December 5, a morning visit to the Inspection Dept. of the Royal Arsenal, Woolwich. Other interesting meetings and visits have been arranged but space does not permit us to deal with them at length. Full particulars may be obtained on application to the Secretary of the Institution.

Nottingham.—The utilisation of waste hot water from the electricity power stations is figuring prominently now in the municipal election campaign. The Labour candidate in one of the big industrial wards in the centre of the city introduced the matter at one of his meetings a few days ago. The idea was promptly denounced as being hare-brained, with the result that technicians have taken a hand in the discussion and point out that central heating is a definitely established feature in all modern American towns, and that in Manchester the waste hot water, instead of being got rid of in cooling towers, is used to heat a huge block of buildings situated near by. Unfortunately for the candidate who first brought the matter forward, the new power station now in course of erection in Nottingham is over two miles away from his ward, and consequently the scheme of laying insulated pipes through existing city roads so that the voters in his district may obtain the advantages of central heating free of charge is scarcely practicable.

B.E.X., 1924.—E.D.A. has issued a well-printed illustration of the great B.E.X. as it appeared at the end of October. Arrows engraved thereon point out the positions of the various buildings, as well as the uses for which they have been designed, and the position which will be occupied by the united display of the electric supply industry is shown boldly within red lines. It should be a grand advertisement for all of us.

Ediswan Catalogues.—Included in a new series of sectional catalogues issued by the Edison Swan Electric Co., Ltd. (123/5, Victoria Street, E.C.4), are the following sections:—D.C. Motors; House Service Cut-outs, Joint Boxes and Colliery Fittings; Accessories; the "Ediswan" House-wiring System; Fans, Wireless Equipment; and last, but not least, Lamps. All are concise, convenient, complete and of the handy size—8¼ in. by 5¼ in.

Meetings.—The Inst. of Production Engineers will meet at 7.30 p.m. on Wednesday, the 21st inst., at the Engineers' Club, Coventry Street, London, W.1, when Mr. A. W. Swan, B.A.Sc., of the Sterling Telephone and Electric Co., Ltd., Dagenham, Essex, will deliver a paper dealing with "The Use of Charts in Engineering." All interested are invited to attend, whether members of the Institution or not, and no tickets are necessary.——The next Wireless Section meeting of the I.E.E. will be held in the Lecture Theatre of the Institution on Wednesday, the 21st inst., at 6 p.m. Subject: "Periodic Trigger Reception," by E. V. Appleton and F. S. Thompson; and "A Dynamic Model of a Valve and Oscillating Circuit," by R. C. Clinker.——The Junior Inst. of Engineers will meet at 39, Victoria Street, Westminster, S.W.1, on Friday, the 16th inst., annual general meeting. Also on Friday, the 23rd inst., lecturette, "Technical Arbitrations," by W. A. Tookey, M.I.Mech.E. (Past-Chairman), and on Friday, December 7, at the Royal Society of Arts, John Street, Adelphi, when Sir J. Fortescue Flannery, Bart., will be inducted President of the Institution and deliver his address. All at 7.30 p.m.

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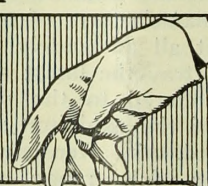
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A POPULAR SCIENTIFIC WEEKLY JOURNAL
ELECTRICITY
A PRACTICAL TRADE JOURNAL

NOVEMBER 23, 1923.

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SIEMENS WIRELESS EQUIPMENT.

At the recent Wireless Exhibition, Messrs. Siemens Bros. and Co., Ltd., made a very effective display, which included the S.B.39 three-valve receiving set, designed with a view to minimising interference from other stations. This set will permit, for instance, of listening-in in London to the Birmingham, Newcastle, or Glasgow stations without any interference from 2LO, even if it is used in proximity to the latter. For this purpose the set is equipped not only with the usual arrangements for tuning the aerial, but also with a loosely coupled closed (secondary) circuit. For the convenience of finding distant stations, or in cases where no interference takes place from other stations, the set is arranged so that it can be used on the aerial circuit alone, cutting out the intermediate circuit. Provision is made for cutting out the third valve (low-frequency amplifier), as this amplification is in many cases not required.

The set consists of an aerial tuner, one H.F., one rectifying valve and one L.F. valve (all "R" type). The valves are on the back of the panel, and the cabinet provides room for the H.T. battery, so that the set is self-contained except for the filament accumulator battery and aerial and earth connections. Thus the set, when installed, requires only four wires, and the only additional apparatus is the accumulator battery. It is therefore particularly suitable for installing in reception rooms, or wherever a compact and neat appearance is desirable. The tuner covers a wave-length of from 300 metres to 2,800 metres with the usual amateur aerial, thus embracing all British broadcasting wave-lengths and French wireless telephone transmissions.

If the aerial and earth are connected to the terminals marked "Aerial 1" and "Earth 1" respectively, the apparatus provides for the use of a tuned closed circuit coupled to the aerial circuit, thus making the set highly selective. Two circular switches, with ten studs each, and two condensers permit of the adjustment of the two circuits for the different wave-lengths. A vernier condenser is provided in the closed circuit so as to facilitate very fine adjustment of the tuning. There are two change-over switches for connecting the condensers in series or parallel with the corresponding inductance.

If the aerial and earth are connected to the terminals marked "Aerial 2" and "Earth 2" respectively, the closed tuned circuit is cut out. This is convenient when searching for distant stations for which the adjustments are not accurately known, or for broadcasting reception in localities where there is little jamming.

The H.F. valve is arranged for a sensitive grid control by means of a potentiometer, whilst the plate circuit of the H.F. valve is tuned to the wave-length of the incoming signals by means of a 10-position switch and a tuning condenser. The rectifying valve contains in its plate circuit a reaction coil (circuit approved by the Postmaster-General), which is coupled to the tuning inductance of the plate circuit of the H.F. valve. A two-way switch is provided for varying the inductance value of this coil, whilst the coupling can be varied by means of a handle mounted on top of the cabinet. The L.F. or note-magnifying valve can be disconnected by means of a switch, so that the set may be used as a two-valve set. The filament of each valve is separately controlled, thus increasing the selectivity of the set. The telephones are connected by means of plug sockets. Two sockets are arranged for high-resistance telephones, and two pairs of sockets for either one, or two pairs of low-resistance telephones. The size of the panel is 18 in. long by 17 in. high by 12 in. maximum depth.

In addition, the Siemens type C.V. simple receiving set was shown, also the two-valve low-frequency amplifier, type S.B.36, which has been designed for use with it. The instrument, which is contained in a compact polished mahogany box measuring about 9 in. by 11 in. by 8 in. high, is fitted with a telephone transformer adjusted for use with 120-ohm. head telephones, so that maximum efficiency is obtained with the same telephones as are used with the receiver type C.V. Sockets are provided for two pairs of head telephones. For use in country districts or other places where there are no facilities for recharging accumulators, the company manufacture a special dry battery for the filament circuit. This battery has a sufficiently large output to permit of the set being worked for one hour per day for about six months at a cost of only slightly higher than for an accumulator, taking into consideration prime cost, renewals, and—in the case of the accumulator—the cost of periodically recharging. D.E.R. valves may be used if thought desirable.

The Siemens loud-speaker, which has good acoustic properties, is made in three types, for 120, 2,000 and 4,000 ohms respectively. The low-resistance type, used in conjunction with a Siemens telephone transformer, is generally recommended, as this arrangement overcomes the troubles inherent in high-resistance receivers due to body capacity effects, and permits of a more robust winding being employed in the loud-speaker.

Other exhibits included inductance coils, telephone head-sets, aerial protective devices, dry cells, ebonite, in the manufacture of which Messrs. Siemens have had

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considerable experience, and ebonite parts, etc. For the telephone head-sets the following advantages are claimed: (1) The terminals are enclosed so as to prevent the receiving circuit being interfered with; (2) the ear-pieces are provided with a groove on the surface to minimise the condensation of moisture; (3) the headband is attached to the telephone receiver by a ball-an-socket joint, designed to allow the ear-pieces to take up a comfortable position against the ear, and also to enable a receiver to be moved without dismantling the headband.

THE GYRO COMPASS.

For many centuries the property possessed by a magnetic needle of pointing to the magnetic north when freely suspended has been known to man. The Chinese claim to have used the magnetic compass as far back as 2,400 B.C., and it has always been one of man's most cherished possessions. Despite the greatest care, however, it has never been an instrument of great accuracy, and of recent years its use in steel ships has become a matter of increasing difficulty. The directive force of the earth's magnetism is small, and in steel ships, where the whole fabric is magnetised, the corrections which have to be applied to it make it a difficult instrument to use. It is only of recent years that it occurred to inventors that it could be replaced by an instrument depending on an entirely different principle. The properties of the spinning top, and its seeming opposition to the force of gravity, have impressed thinkers of many ages, and volumes have been written on the subject. All this research, however, has only seemed to complicate matters, and it has been left to the present generation to sort out from the mass of abstruse calculations of older mathematicians the work which was of practical value. The first gyroscopic compass was made by Foucault. It had three degrees of freedom, *i.e.*, it could move in three directions normally inclined to one another. About two years later, Hopkins applied an electric motor to Foucault's gyro, and with this electrically driven instrument obtained far better results. This gyro was satisfactory on a stationary body, but when subjected to movement acted in the same way as a pendulum, responding to acceleration pressures and various other disturbing factors, thus setting up oscillations which made the instrument useless at sea. Modern inventors have produced an instrument which is sufficiently sensitive to the movements of the earth, but not affected by the greater disturbing forces due to the motion of a ship.

The underlying principle of the gyro compass is this: Any rotating mass follows different laws from those which apply to bodies at rest. For instance, a spinning wheel can be moved in a straight line without resistance or reaction; but if it be moved in a curved path different phenomena are observed. The wheel will always tend to move in such a direction as to bring its axis of rotation parallel to the axis of any external angular force, and so that its direction of rotation is the same as the direction of rotation of the angular force. Angular motion of this sort is known as Gyroscopic Precession. This principle of Precession, together with Fixity of the plane of rotation, form the basis of the action of the gyro compass. The principle of Fixity of the plane of rotation is illustrated by Fig. 1. It is the property a spinning wheel possesses of maintaining its axis in a fixed direction in space.

In Fig. 1, suppose A to be a rotating wheel, having three degrees of freedom, and mounted upon a rotating body. If the body is rotated through 45 degrees, in the direction shown, the wheel will move to A^1, keeping

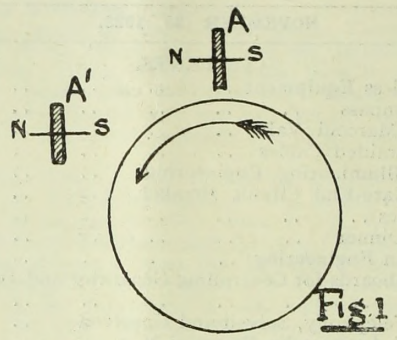


Fig. 1

its axis in the same direction as at A, and its plane of rotation parallel to that at A. It will be noted that the relative effect is equivalent to the rotating body being fixed, and the end marked N rising.

Now replace the spinning wheel by a gyro compass, and the rotating body by the earth. Assume the compass to be at the equator, and the end of the wheel shaft marked N to be pointing east. As the earth rotates the wheel will maintain its plane of rotation fixed in space, which is equivalent to the N end of the wheel rising, as in the previous case. Fig. 2 is a diagrammatic representation of a compass: a is the

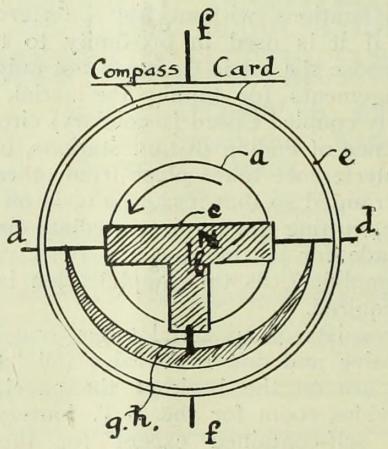


FIG. 2.

spinning wheel or gyro, and is mounted in horizontal bearings b; c is a horizontal ring mounted on a vertical ring e by means of bearings d—d. The ring e can also turn on a vertical bearing f. Connected to c at the point h is a pendulum g.

As the N end of the wheel rises the pendulum g rises, and will apply a torque to the ring c, and, therefore, to the wheel a about the horizontal axis d—d. This torque, instead of causing motion about d—d, causes precession about f—f, and counter-clockwise, *i.e.*, the N end of the wheel will move towards the north. The north end of the wheel will continue to rise until the axis of spin lies in the plane of the earth's axis. The velocity of precession is then a

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maximum on account of the maximum inclination of the axis of the wheel. This will carry it past the meridian, after which the *N* end of the axis will begin to fall, as it will then be in the position *S* in Fig. 1. With the arrangement shown in Fig. 2, the wheel will precess to a position as many degrees west of the meridian as it originally was east, after which it will swing back again to its original position. This is overcome by mounting the pendulum *g* in a slightly different manner, so that the torque is applied to an axis slightly inclined to *d*—*d*. On this account, if the wheel is started, say, 90 degrees east of the meridian, it will cross the meridian to a point about 30 degrees west, then back to 10 degrees east, etc., and presently settle exactly on the meridian.

In the "Sperry" gyro compass the wheel rotates in vacuo at about 8,600 r.p.m., and a directive force is developed of about 200,000 dyne-cm. at the equator. It can, therefore, be simply proved that the directive force of the gyro compass is about 290 times as great as that of the magnetic compass.

Whilst on land, the directive force of the gyro compass is due wholly to the easterly motion of the earth, but when mounted on a moving body the gyro receives a mixed motion, which gives a deflection from the meridian. This deflection is due to three variables: the speed, meridianal component of the course, and the latitude. As a result of this mixed motion, we get a total deflection given by the formula:—

$$D = c_1 \frac{S \cos H}{\cos L} \pm c \tan L$$

Where *D* is the total deflection, *c* and c_1 are constants, *H* is the number of degrees between ship's head and north, *S* is speed in knots, and *L* the latitude in degrees. This formula is not used, however, owing to the introduction of an automatic correction apparatus, by means of which all the components of deflection are compensated for, so that all readings of the compass are held directly on the meridian.

One of the many advantages of the gyro compass over the magnetic is that its readings may be electrically transmitted to any number of repeating compasses. Hence the master compass can be placed in any part of the ship, a distinct advantage in the case of ships of war, when it is essential that the master compass be under armour.

DRY BATTERY MARCONI VALVE.

One of the most interesting exhibits made by the General Electric Co., Ltd., at the All-British Wireless Exhibition was a new Marconi valve (type D.E.3) for operation by a dry battery, the filament current being 0.06 amps. at 2.4 to 3 volts. The characteristic enables it to be used as a detector, or as a low or high frequency amplifier, in substitution for the ordinary "R" type valve in standard receiving sets. The plate voltage which may be applied can be varied between the limits of 30 and 80, the general value being of the order of 45. As emission of this valve is 6 milliamps, it is suitable for working a loud-speaker. By the marketing of this type of valve isolated country places with no accumulator charging facilities are now able to listen-in. At the same time the demand for portable loud-speaker receiving sets for use out of doors is likely to increase.

PACKING OF BRAIDED CABLES.

All sizes of braided cables up to 7/.029's inclusive, both CMA and NA, are now packed by British Insulated and Helsby Cables, Ltd., in a separate circular cardboard box. This supersedes the method of wrapping the coils with hessian.

The boxes are unique, being manufactured to the company's registered design. The advantages, which should prove good selling points, are:—

(1) The coils in boxes are as convenient to handle as the hessian lapped coils, as owing to a circular hole which is provided in the centre of the box one or more coils can easily be carried on a wireman's arm.

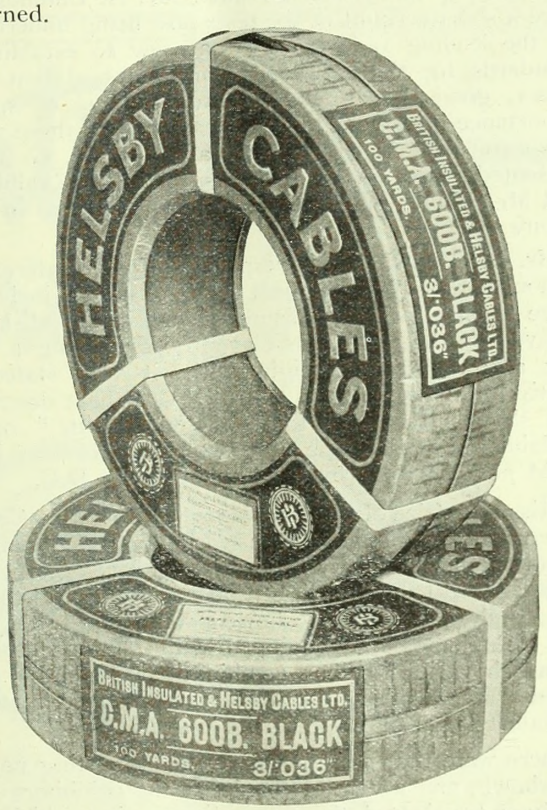
(2) All that is necessary in order to get at the coil is to cut three tapes and then to lift the coil out of the box. This does away with unwinding long lengths of hessian, thus preventing the untidiness now prevailing when the coils are unwrapped.

(3) The boxes are distinctively printed in red and black according to the colour of the cable, and they may be picked out at a glance.

(4) If the whole coil is not used, the remaining portion can be put back in the box and kept in good condition.

(5) Each box is clearly labelled so as to show the size and grade, or class of cable, and this should prove useful to anyone stocking the cables, as the particular cable required can be identified at once, and, in addition, the CMA or NA sealed label respectively is round the coil as in the past.

(6) The box is not charged for and need not be returned.



Stock orders now supplied are contained in the boxes, but the B.I. and H. Co. hope, however, that every effort will be made to dispose of old stock before starting to sell the boxed cable.

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PROGRESS IN ILLUMINATING ENGINEERING.

The opening meeting of the Illuminating Engineering Society took place on November 13, the chair being taken by Mr. L. Gaster, who also presented the usual report of progress during the vacation. Mr. Gaster remarked that industrial lighting continued to receive much attention, a feature being the good results that had followed co-operation between the Home Office Factory Department and the Joint Industrial Councils of leading industries. A recognition of the importance of illumination is afforded by the appointment of a special committee to deal with outstanding lighting problems by the Department of Scientific and Industrial Research, and by the creation of the Association of Public Lighting Engineers, which will, it is hoped, do useful work in supplementing the efforts of the Illuminating Engineering Society to improve street lighting. Another sign of the times is the increasing attention being paid to propaganda work by the leading firms concerned with lamps and lighting appliances, which can also do good work in making the conclusions arrived at in discussions of the society more widely known.

The report of the committee on progress in lamps and Lighting appliances also laid stress on these educational efforts and on the growing tendency towards standardisation exemplified by agreement on a series of standard lamps for motor-car headlights suitable for all the leading British makes of cars.

Following Mr. Gaster's report, Mr. A. Cunningham gave a short account of the tests now being undertaken on the leading railways with a view to establishing standards for the lighting of important station platforms, goods yards, etc. The latter is of special importance in view of the fact that work in these yards is so consistently done by night. Mr. J. G. Clark presented a brief review of the National Gas Exhibition, and Mr. Phillip Sugg alluded to developments in gas-fixture design.

Mr. L. E. Buckell was responsible for an interesting demonstration of some recent forms of lamps, including large gasfilled types consuming 3-4 kw. and lamps sprayed by the new china-clay process, giving a very soft and well-diffused light with, it was stated, a relatively low absorbtion. Mr. E. Greetham described and showed the new form of "Pointolite" outfit, explaining how, for the first time, this form of lamp could now be used for A.C. as well as D.C.

Miss Beatrice Irwin explained the Irwin Colour Filter system and showed a variety of hand-painted cylinders in pleasing combinations of colours which were claimed to give a light that is very restful to the eyes, and Capt. Stroud showed some highly decorative Holophane units equipped with an inner screen by which various colour combinations could be produced. Mr. E. T. Ruthven Murray exhibited some of the latest types of "Internalite" signs.

There were thus quite a variety of interesting novelties shown, and a vote of thanks to the exhibitors and speakers terminated the proceedings, after which the chairman announced that the next meeting would be held on December 11, when a paper on "The Application of Illuminating Engineering in Practice" would be read by Mr. G. Herbert and Mr. R. A. Ives.

AN ELLISON GATE-END CIRCUIT BREAKER.

For the many engineers preferring an air-breaker instead of an oil-break circuit breaker in collieries, where a portable automatic circuit breaker is used at gate-ends with a plug connector for a trailing cable, a new George Ellison design fulfils all the duty requirements and complies with the Coal Mines Act.

This Ellison magnetic blow-out gate-end breaker is contained in a heavy explosion-proof cast-iron box mounted on a sleigh or "skid" frame, with a plug and socket trailing cable connector fitted to the case and interlocked with the operating handle.

The apparatus is heavy because of the liberal use of materials in its construction, but it can be transported without risk of injury to its parts, and the sleigh-mounting enables it to be easily hauled over rough ground.

The circuit breaker is the magneto blow-out type for both A.C. and D.C., with a high breaking capacity controlled by an effective series connected magnetic field. Its parts are assembled on a cast-iron frame which is bolted in the case. The complete breaker, together with the no-volt and overload releases and time lags, can be removed easily from the box for overhauling.

The handle is a massive gun-metal casting, limited in its travel by stops plainly marked to show the "on" and "off" positions, and no undue stress can be thrown on the internal moving parts. One handle suffices for closing and opening the breaker, and it is "free" of the breaker if automatic release conditions prevail. The trip adjustment and time lag devices are inside the case, so that they cannot be interfered with by unauthorised persons.

The plug and socket connector for the trailing cable is contained in gun-metal casings interlocked to prevent the withdrawal of the plug when the breaker is closed, and the fixed contact half is provided with a screw cap which may be locked in position when the plug is not in use. The plug contacts are of Ellison's patent spring type, comprising spears of copper rod which enter sockets made of phosphor-bronze spiral springs contained in cylindrical blocks. Arrangements are provided to secure an efficient earthing connection in accordance with H.O. Regulations.

The plug connector, which will take C.T.S. cables up to 248/.018, may be arranged to insert one way only, or a reversible plug can be supplied to change the direction of rotation of the motor.

Tenders Accepted.—Siemens and English Electric Lamp Co., Ltd., have secured a contract from the Admiralty for the supply of a large number of their Spiralised Metal Filament Traction Type Electric Lamps.

Meetings.—The joint meeting of the I.E.E. and the Société des Ingenieurs Civils de France (British Section) was held in the Lecture Theatre of the Institution on Thursday, 22nd inst., at six p.m. Paper: "The Electrification of the Midi Railway," by Monsieur A. Bachellery.

The Engineers' Club.—At the second annual general meeting which was held on the 14th inst., the president, Sir Robert Hadfield, was in the chair, and congratulated the members on the results shown in the report and accounts, which he thought were surprisingly good in view of the adverse trading conditions in the engineering industry during the last twelve months. Sir Joseph Isherwood, Bart., was elected president for the ensuing year, and Sir T. Harris Spencer and Mr. C. H. Wordingham were elected vice-presidents. Mr. Howard Foulds was elected to the board to fill a vacancy caused by the death of Mr. H. T. Wilkinson.

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BRITTAIN'S ELECTRIC MOTOR CO.

(Formerly Langdon-Davies Motor Co.)

110, Cannon St., London, E.C.

Telegrams: "Damophon, London."
Telephone: City 2744, 2745.

Works: **LEWISHAM, LONDON, S.E.**
Telephone: Lee Green 1473.

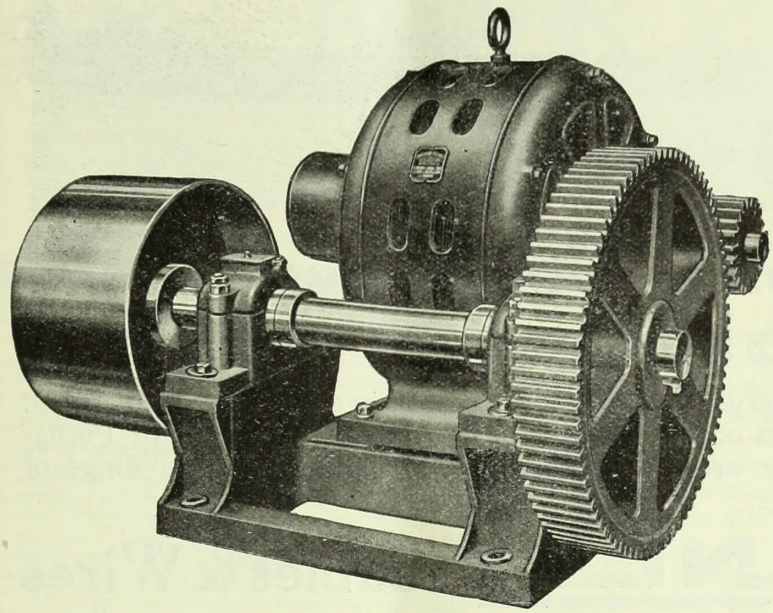


Illustration shows a 40 B.H.P. Standard Back-gear Motor.

NOTE the Robust design maintained throughout.

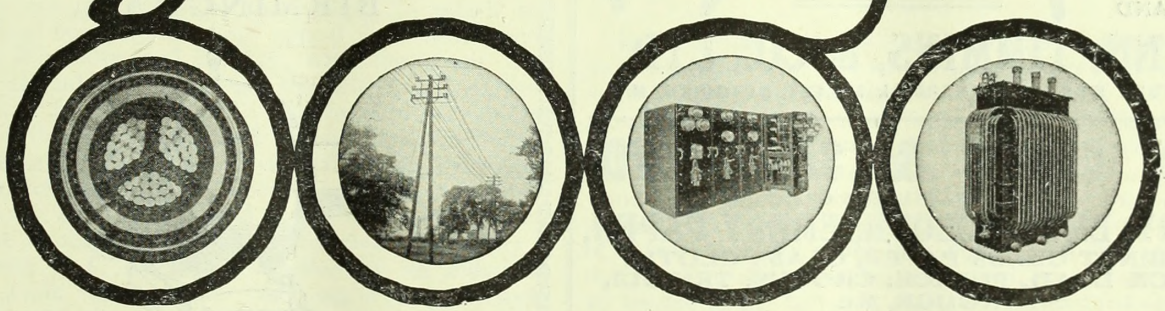
MAKERS of SINGLE and POLYPHASE MOTORS of every description.

With over 30 years' experience behind us the excellence of our design and workmanship has never been questioned.

Reorganisation and improved methods of manufacture have enabled us to **reduce our prices,** while maintaining at the same time our high standard of quality.

YOUR ENQUIRIES WILL BE PROMPTLY DEALT WITH.

All we advertise for— Your enquiries for

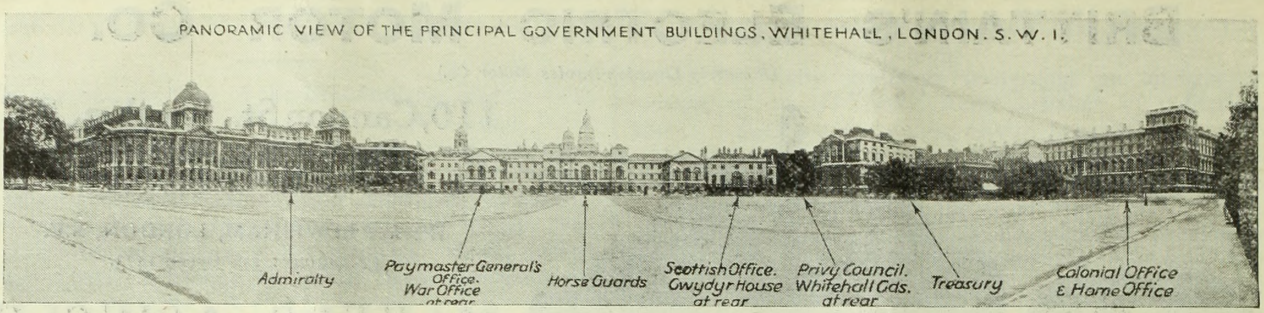


Of course we really want your orders, but we don't advertise for them. When we have induced you to send us your enquiry, the task of our advertising department is accomplished. We then have the opportunity of putting our case before you in the form of a tender supported by explanatory literature, illustrations, drawings and examples. We rely on being able to satisfy you as to price, quality, design and delivery. If it seems desirable to discuss our proposals on the spot, one of our engineer representatives is ready to wait upon you for this purpose. Should you, after all, decide to place your order elsewhere, we shall make one request only in accepting your decision, *i.e.*, that you continue to send us your enquiries, and allow us to try again.

Johnson & Phillips, Ltd., Charlton, London, S.E.7.

City Office and Stores—12, Union Court, Old Broad Street, E.C. 2.

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The most important buildings in the British Empire.

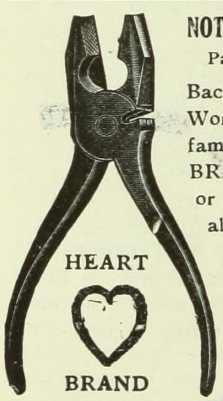
Buildings where matters affecting every interest of every person in the Empire are decided. As important, perhaps, as the Houses of Parliament, for in them the decisions of Parliament are put into practice. They are the *Government* Buildings—the buildings of Government, and they are all being

re-wired with HENLEY Cables & Wires

by Mann, Egerton & Co., Ltd., Norwich & London.

W. T. HENLEY'S TELEGRAPH WORKS CO., LTD., Blomfield Street, LONDON, E.C.2

Makers of Electric Cables since the beginning of Electrical Transmission.

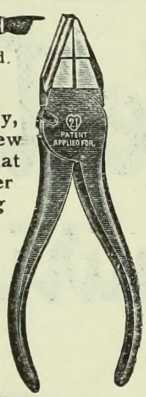


NOTICE THE REAMER ON JAWS

Patent applied for and design registered.

Back view of our World-known and famous "HEART BRAND" Cutting or Bell Pliers in all sizes, 4 in. to 7 in. rising by ½ in., and 8 in., 9 in. and 10 in. sizes.

C. 200R. 6 in. size only, something new in Pliers, that is a reamer for removing burrs inside of conduit tubing without the use of extra tools



WYNN, TIMMINS, & CO., LTD.

CENTURY WORKS, COMMERCIAL STREET, BIRMINGHAM.

JOHN OAKEY & SONS, LTD.

MANUFACTURERS OF

EMERY, EMERY CLOTH, EMERY PAPER,
CABINET GLASS PAPER, GLASS CLOTH,
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Oakey's "Flexible Twilled" Emery Cloth.

For Engineers, Sewing Machine, Lock and Scale Makers, and all purposes where great STRENGTH, DURABILITY and PERFECT FLEXIBILITY are required.

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50 yards long by 18 in., 20 in., 24 in., 30 in., 36 in., 40 in., 42 in., & 43 in. wide.

"WELLINGTON" EMERY WHEELS.

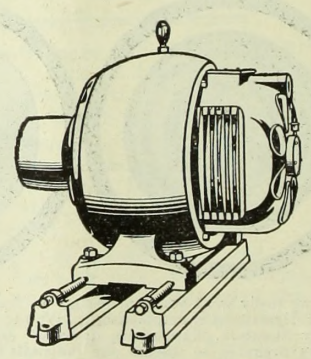
WELLINGTON EMERY AND BLACK LEAD MILLS, LONDON, S.E.1

ALL BRITISH MADE.

If you must buy a Motor, see that it's BRITISH, and if you want the BEST it will bear this mark—

TRADE HIGGS HB BROS ELECTRIC MOTORS MARK

BIRMINGHAM.

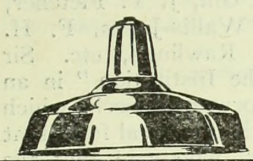


265, STRAND, W.C.2 - - - - City 5956.
3, YORK ST., MANCHESTER - - City 3713.
84, ALBION STREET, LEEDS - - 22762.

We are building new works at WITTON.

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Don't worry! THERE IS A BENJAMIN REFLECTOR for EVERY CLASS of LIGHTING INSTALLATION.



Advt. of the Benjamin Electric Ltd., Brantwood Works, Tariff Rd., N.7

TO OUR READERS.

ELECTRICITY is published every Friday, and, if ordered, is on sale at the principal Railway Station Bookstalls and Newsagents on that day. It has a very large sale throughout the United Kingdom, as well as in the British Colonies and Abroad.

New advertisements for the displayed columns and alterations to existing ones must reach the publishing office not later than first post Tuesday morning, in order to be in time for the issue of the following Friday. This is important. Rate quoted on application. Subscription : 13s. a year, 6s. 6d. half-year, 3s. 3d. a quarter in advance, postage prepaid in the United Kingdom and abroad.

Questions to which an answer is required must be accompanied by a 1½d. stamp for reply. When considered of sufficient interest, the answer will probably appear in the paper.

All remittances payable to the Publishers, S. RENTELL AND CO., LTD., 36-39, Maiden Lane, London W.C. 2. Telephone No. 2460 Gerrard.

Current Topics.

The Flashing Sign.

The era of the scintillating, flashing, kaleidoscopic, pictorial, and announcing sign is undoubtedly in being, and in Central London, at all events, it is difficult to lose sight of some form of illuminated and attractive advertisement at any time after sunset. These signs constitute a great attraction and unquestionably rivet the attention of the public for the time being; but their lay-out and design calls for the most careful consideration, if they are to prove a real success as advertising media. The more ingenious, highly coloured, and attractive examples claim the longest attention on the part of the onlooker, but this is to little purpose if the scheme of the sign is not more or less directly associated with the character of the goods it is supposed to advertise.

There are too many of these signs in which the underlying basic advertising appeal has been sacrificed to ingenuity and novelty, with the result that people remember and discuss the latter, but entirely overlook or forget the former, and the sign thus misses its "pull." Of the manifold varieties of these signs now extant I am inclined to yield the true advertising palm to the Geissler tube effects, in which the name, trade mark, or slogan is laid out in bent glass tubing rendered luminous in various attractive colours by a continuous H.T. discharge supplied by an induction coil or Tesla transformer. Such signs are extremely effective, and, due to the uninterrupted outline of the picture or lettering, are much more legible and prominent than the examples which rely upon a series of individual bulbs mounted to form a design or text.

There is another point about these signs which is well to bear in mind, having regard to the ever increasing popularity of broadcasting. They constitute an addition to the many disturbing factors in London, and other large cities, which have an influence on the quality of the received speech or music. As all listeners-in will be aware, it is a physical impossibility to obtain good and clear results from broadcasting in the centre area of London and other cities and towns where electric railways, tramways, lifts, motors, A.C. power, and other influences abound. It is these disturbances which contribute in no small degree to the universal failure of public demonstrations of broadcast reception. Were I in the trade I should never demonstrate to my clients in town, but locate my demonstration set in a favourable suburb, away from these disturbing influences.

The flashing sign contributes its quota to the extraneous noises of broadcast reception, and as an indication that this influence is recognised, these signs at the recent All-British Wireless Exhibition at the White City, Shepherd's Bush, were ordered to be switched off during broadcasting hours, so that they should not interfere with the demonstrations of transmission and reception given in the hall itself during the progress of the Exhibition. Incidentally, the phenomenal success of this, the second annual All-British Wireless Exhibition and Convention to be held in London, entirely negatives the prophecies of those dismal pessimists who foretold that broadcasting was only a passing craze, and would soon die out, like roller-skating. On the contrary, it has undoubtedly caught the public fancy, and the world and his wife have been to Shepherd's Bush during the last ten days.

At the time of writing these notes the Exhibition is still open, and has yet three days to run before the original fortnight is completed. Notwithstanding this long run, the attendance shows no signs of falling off, and the halls, during the afternoons and evenings more particularly, have been constantly crowded with interested visitors and trade representatives from all over the country, anxious to fix up contracts for the season's trade, and inspect the goods of the leading wireless manufacturers at first hand. If the experiences of the stand attendants are anything to go by, there is a very humorous side to wireless, born no doubt of popular ignorance concerning technical details.

For example, there is the case of the dear old Lancashire dame with a four-valve set, who is delighted with results, but still unable to understand the function of "they lamps in ta little bottles"! Then there was the elderly gentleman obviously afflicted with deafness in one ear, and desirous of purchasing a single-hand receiver, who thought a certain hand *transmitter* far too heavy for prolonged listening in. The complaint of a lady that she could hear nothing on "a set like that," which she had at home, proved, on investigation, to be due to the fact that the lady had earthed one tag of the headphone cord and connected the other to a full-fledged aerial, believing in all innocence that her equipment included all essentials to successful reception of 2LO. This pardonable error is scarcely comparable with that of the youth who asked if a 16-point anti-capacity switch was a variable grid leak, and his counterpart, who mistook a grid leak for a H.T. fuse.

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Ancient and Modern.

Being in the City with an hour or two to spare the other day, I visited the Tower of London for the first time since I went through as a small and awestruck boy. It is, and always will be, a most interesting and historical monument and museum of this country's past history, and the collection of arms and armour itself is alone worth a minute study. The "Beefeaters" are most courteous and always ready and willing to describe the wonders of London's premier fortress in minute detail. They are well versed in historic lore, and have a distinct vein of humour which runs through their narratives to successive groups of visitors. I viewed once more the block and axe used to remove the head of Lord Lovat; there are two notches still in evidence in the hard wood surface, which would appear to indicate that two strokes were necessary to accomplish this task. The full armour worn by Henry VIII. bears out his traditional corpulence, whilst the presumed signature of Lady Jane Grey, cut in the stone wall of the apartment in which she was imprisoned, is a masterpiece of neat and patient chiselling with, presumably, primitive implements.

It is an extraordinary contrast, and prompts reflection on advancing civilisation, that this building, originally constructed during the reign of William the Conqueror, and lit no doubt by the torches of that period, now boasts a comparatively modern electric light installation, although I noticed some of the bulbs were of obsolete type and called urgently for renewal. The Crown Jewels are well lit for display purposes by linolite lamps arranged to outline the cases and obviate glare, whilst at the same time bringing out the beauties of these magnificent jewels and the precious metals of their mountings to perfection. All readers who have the opportunity should revisit the Tower of London. It is an education in itself.

Benevolence.

I congratulate Sir Philip Nash, K.C.M.G., on his collection at the annual dinner of the Electrical Trades Benevolent Institution, which was held at the Trocadero on the 14th inst. Considering the size and importance of the electrical industry, the funds which have so far been collected or bequeathed for this most worthy object ought to make us blush for our meanness, and I can but hope that the strenuous efforts made by the committee and the ever-energetic Hon. Sec., Mr. F. B. O. Hawes, will meet with a more ample reward in the very near future. Year by year fresh seed is, so to speak, being sown in the way of appeals to the trade for support, but until those appeals result in really substantial additions to the invested capital it is hopeless to think of granting pensions to the many cases which come under the notice of those who control the funds. Assistance is rendered, and generously so considering the income, but that is not the point. The Institution is not supported as it ought to be by the rank and file of the electrical trade, by and for whom it has been founded. They do not seem to grasp the fact that after contributing a very modest sum annually for a short period of years they become entitled to the benefits should they fall on evil times. I can therefore most strongly exhort my readers to write to Mr. Hawes and ask him to enter them as members. A note to 18, Park Mansions, London, S.W.8, will receive a prompt reply giving full details.

The dinner itself was a very pleasant function, and about one hundred ladies and gentlemen were present, including such well-known stalwarts as Messrs. Dane Sinclair, Ll. B. Atkinson, Frank Gill, J. Y. Fletcher, R. W. Hughman, Capt. R. J. Wallis-Jones, F. H. Nalder, Chris Wilson, W. R. Rawlings, etc. Sir Philip proposed the toast of "The Institution" in an eminently practical and straightforward speech, which was well seconded by a really touching appeal from that veteran Scot, Mr. Dane Sinclair, who said that the president had appealed for the deserving, and he would appeal for the undeserving, who ought to be helped without inquiring too closely into the causes of their fall. Mr. Fletcher proposed the toast of "The President" in a very able manner, and then went on to elaborate the point to which I have already given prominence in regard to the slackness of the members of our industry. He reckoned them at 200,000, and said that if only 50,000 of them were members at 10s. per annum it would mean an assured income for the fund which would place it at once on a sound basis and of real benevolent value.

Sir Philip expressed his grateful thanks for the enthusiastic way in which the toast had been received, and then went on to announce that the various collections, plus the amount collected at the dinner table that evening, represented, roughly, a total of £1,250, or about £400 more than 1922, and then concluded his remarks by proposing the health of Mr. F. B. O. Hawes, who, as Hon. Sec., had worked so hard and so continuously for the welfare of the fund. Mr. Hawes, in reply, said that he was hopefully looking forward to the time when they could grant pensions, but in the meantime it was necessary that the funds should be piled up much more rapidly, and remarked that the Institution had not so far been very fortunate in the way of legacies compared with those which had been left to other similar funds, and he looked forward to that point of view being more carefully considered and acted on in the future. He also appealed for greater support from provincial centres, and cited as good examples the collections made in Cardiff, Manchester and Newcastle, which ought to be emulated by towns like Leeds, Liverpool, Birmingham, etc.

An excellent musical programme arranged by Mr. Bernard Flanders added much to the enjoyment of the evening, and I sincerely hope that the ultimate results will more than reward the labours of those who have worked so hard in this most charitable cause. It is honestly worthy of it.

Progress in Illuminating Engineering.

The opening meeting of the Illuminating Engineering Society on November 13 was, as usual, devoted to a series of varied exhibits which included new forms of electric lamps, colour-systems, headlights, etc., and the various reports showed that much has taken place during the vacation. In Mr. Gaster's opening address, and again in the report on progress in lamps and lighting appliances,

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stress was laid on the need for more widespread propaganda. I am glad to see that the Society is alert to this need. As a result of fifteen years' work the information available on lighting is very considerable, and the problem is how to make this known to the general public. Several of the leading firms have taken enterprising steps in this direction, and, if all such efforts can be co-ordinated so as to supplement the work of the Society, we should see marked improvements in illumination during the next few years.

ELEKTRON.

THE BEAMA DINNER.

Congratulations to the President, Chairman of Council, Secretary, and, indeed, to all members of the British Electrical and Allied Manufacturers' Association on the undoubted success of the dinner at the Connaught Rooms on Thursday, the 15th inst., when H.R.H. the Prince of Wales, K.G., as the principal guest of the evening and the leading commercial traveller of the British Empire, gave us one of his invigorating speeches, which ought to go far towards ensuring the complete success of the electrical engineering section of the great exhibition at Wembley in 1924. About 700 were present at the dinner, including men representing every branch of commercial and industrial activity, and they were presided over by the Earl of Derby, K.G., who is the President of the Association.

In proposing the loyal toast, Lord Derby welcomed the Prince most heartily as the President of the British Empire Exhibition, and said that he was a remarkable asset to our nation, by which the President meant not only our own island, but also those great nations beyond the seas, where the Prince was so deservedly popular. The humorous racing similes which accompanied the toast were in excellent spirit and, needless to say, it was cheered enthusiastically.

In reply the Prince of Wales expressed his gratitude for the reception due to the toast, which was really that of the Queen, and said how pleased he was with the way in which the Beama was supporting Wembley in 1924, and remarked that he was relieved to find that his acceptance of the invitation had not involved him in the necessity for resuming his studies of electricity which he had discontinued about ten years ago, although he had not forgotten all about it. He spoke in terms of high praise of the way in which our scientists and workmen had come forward during the Great War and proved that we were just as virile and inventive as ever, and felt confident that it was in our power to keep the lead in electrical development in this age as in the last we had held it in steam.

At the conclusion of an excellent and well-thought-out speech, His Royal Highness gave the toast of "Imperial Trade and Resources," to which a reply was given by the Right Hon. L. S. Amery, M.P., First Lord of the Admiralty, who stated that one of the great problems of the Empire was how to marry the human capacities of our people to the boundless resources of our common heritage, viz., fifty millions of people huddled together in one little island off the coast of Europe and fourteen millions of square miles of the richest country of the world on the other side of our Empire. Whatever our policy of government we must remember that men, money and markets formed an inseparable trilogy in the problem of Imperial development. Quick and easy communications were the groundwork of all civilisation and trade, and in the spread and development of communications electrical science would play a most important part in the future of the Empire, enabling its people to move freely to and fro and to keep in touch with each other.

Lord Derby proposed the toast of "Our Guests," remarking that they welcomed representatives from the great Dominions, which were becoming more and more dominating partners in our great Empire, and excellent replies were given by Sir Patrick McGrath, of Newfoundland, and Sir Chas. Morgan, President Inst. C.E., after which Mr. B. Longbottom, the Chairman of the Council, very ably and humorously proposed the toast of "The Chairman, Earl Derby," who elicited much laughter at his reference to the statement that whereas Newfoundland has hitherto been supplying paper at the rate of 200 tons daily, it is now hoped to load our breakfast tables with news at the rate of 600 tons daily. As he said, "A truly awful prospect."

RETURN OF C.S. *FARADAY*.

The new cable steamer *Faraday*, belonging to Messrs. Siemens Brothers and Co., Ltd., of Woolwich, has now returned from her maiden cable-laying expedition. She has successfully completed the laying of the section of cable connecting New York and Canso, Nova Scotia, about 1,000 miles; notwithstanding the fact that she encountered exceptionally bad weather, during which a mishap occurred to the cable and the end was lost in 3,000 fathoms of water. The vessel here proved her excellent qualities as a cable steamer, as the end was recovered very quickly, and the whole section completed to the satisfaction of the engineers of the Commercial Cable Company, who have had it in continual use since laying. This section forms a part of the Commercial Cable Company's new cable connection between America and England, which has the greatest traffic-carrying capacity of any existing cable.

SCHOLARSHIPS IN ENGINEERING.

The Beama Council have recently granted the following scholarships tenable for one year, each of the value of £100, and the payment of college fees:—

In Electrical and Mechanical Engineering.—To John Douglas Cockcroft, tenable at Cambridge University; and to Arthur Bernhard Everest, tenable at Birmingham University.

In Electrical Engineering.—To George Knowling Franklin, tenable at Manchester College of Technology; to George Sail Campbell Lucas, tenable at City and Guilds (Engg.) College, South Kensington; to Richard Cyril Matthews, tenable at City and Guilds (Engg.) College, South Kensington; to Henry Letham McBroom, tenable at the Royal Technical College, Glasgow; to John Leonard Orme, tenable at Birmingham University; to Cecil William Richards, tenable at City and Guilds (Engg.) College, South Kensington; and to Rowland Wright, tenable at the City and Guilds (Engg.) College, South Kensington.

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G.E.C. SWITCHBOARDS FOR CONTROLLING GENERATOR AND BATTERY PLANT.

For the control of self-contained electric lighting and small power equipment for supplying country houses, farms, bungalows and other isolated residences, a new switchboard, type "G.B.," has been designed by the General Electric Co., Ltd. Special attention has been given to the simplification of the switchgear and connections, and the boards may be manipulated by unskilled or semi-skilled labour without fear of mistakes in switching being made. There are two standard types made, the "G.B. Junior," for capacities up to 20 amps., and the "G.B. Senior," for capacities from 30 amps. to 200 amps. In each instance the panel consists of a slate slab enamelled on the face and all edges, mounted with suitable instruments, switches, cut-outs, etc. The smaller size board is mounted with a 3-inch dial oval pattern moving iron, spring-controlled instrument, while the larger board has 6-inch dial bound instruments.

With these boards it is possible to (1) charge the battery only; (2) discharge the battery only; (3) charge the battery and supply a light and power load simultaneously.

One of the well-known Salford battery automatic cut-in and cut-outs is supplied with each board, a space being left underneath for a shunt regulator for the dynamo.

PROBLEMS IN TELEPHONY, SOLVED AND UNSOLVED.*

By Professor J. A. Fleming, M.A., D.Sc., F.R.S.

(*Continued from page* 600.)

III.—Sound-wave Energy and Amplitude Necessary for Audition.

(3) During the last fifty years a large amount of research work has been done in determining the aerial wave energy per square centimetre per second which must be passing at a certain frequency in order that the ear may just perceive it as an audible sound, or, alternatively, a sound of a certain pitch and loudness. In 1870 Töpler and Boltzmann† made one of the earliest determinations with an organ pipe of pitch 181, and found for the maximum compression S a value $S=6.5\times10^{-8}$. The corresponding R.M.S. pressure is about 1/15 dyne per cm^2 when the sound was just audible. In 1877, Lord Rayleigh‡ used a whistle blown under a pressure of 9.5 cm of water taking 196 cm^3 of air per second and giving a sound of frequency $n=2{,}730$. The work done per second in blowing the whistle was then $196\times9.5\times981=1{,}826{,}622$ ergs. He found that the whistle could just be heard in the open air in all directions at a maximum distance of 821 metres. Assuming all the energy to be expended in sound production and to be equally distributed over the hemisphere surface, this gave the value of the wave energy (W) in ergs per cm^2 per second as 43 micro-ergs. Then from formula (7) :—

$$W=\tfrac{1}{2}\rho c\omega^2A^2,$$

and from the relations $\dot{A}=A\omega$ and $S=\dot{A}/c$, where $\dot{A}$ is the maximum velocity of the air particle, A its maximum displacement and S the maximum condensation, he found at once $\dot{A}=0.0014$ cm/sec, $A=8.1\times10^{-8}$ cm and $S=4\times10^{-8}$. The R.M.S. value of the variable pressure is then 0.04 dyne per cm^2.

This result showed how extremely small is the amplitude of periodic motion of an air particle which can produce a just audible sound. A length of 10^{-8} cm is called 1 Ångström unit (Å.U.); the length of a wave of yellow light is about 5,000 Å.U. and the diameter of a molecule about 1 or 2 Å.U. The maximum displacement of the air particle in the above case was only 8 Å.U., or about 1/600th of the length of a wave of yellow light.

(4) There are objections, however, to measurements made over large distances in open air, and hence in 1894 Lord Rayleigh employed a tuning fork of frequency 256 as a source of sound and determined the rate of energy emission from the rate of decay of the oscillations.§ He found that when the fork was emitting sonorous energy at the rate of 42.1 ergs per second it could just be heard at a distance of 27.4 metres. This gives a mean density of wave energy per second over the hemisphere of 0.9 micro-erg per cm^2.

Calculating from the above formulæ the maximum amplitude and condensation for just audible sound waves, he found $A=12.7\times10^{-8}$ cm and $S=0.6\times10^{-8}$ at a frequency of 256. In 1894 Lord Rayleigh made a third measurement by the aid of a telephone receiver.‖ He measured the displacement of the diaphragm when a certain direct current was passed through the coils. He measured also the displacement of the diaphragm produced by a certain mechanical force reckoned in grams weight applied to it, and from these figures he inferred that an alternating current of 0.83 micro-ampere at a frequency of 256 p.p.s. produced a deflection of 6.8×10^{-8} cm = 6.8 Å.U. at the centre of the diaphragm. He estimated that the effective area of the telephone diaphragm in producing sound waves was 4 cm^2, and that the volume of the cavity of the external ear contained between the ear-drum and the diaphragm of a telephone pressed against the ear was 20 cm^3. Hence it follows that the maximum condensation S was 1.4×10^{-8} at a frequency of 256, and the corresponding amplitude of the air particle 2.9×10^{-7} cm. Lord Rayleigh's three experiments therefore gave for the condensation and amplitude of the just audible sound the following values :—

By whistle at $n=2{,}730$; $S=4.1\times10^{-8}$, $A=8.1\times10^{-8}$ cm.

By tuning fork at $n=256$; $S=0.6\times10^{-8}$, $A=12.7\times10^{-8}$ cm.

By telephone at $n=256$; $S=1.4\times10^{-8}$, $A=29\times10^{-8}$ cm.

Approximately speaking, we may say that at a frequency of 256 the ear detects as sound a periodic change in air density of 1 hundred-millionth of an atmosphere, an

* Lecture delivered before the Institution of Electrical Engineers, to whom we are indebted for the illustrations.

† *Annalen der Physik*, 1870, vol. 141, p. 321.

‡ *Proceedings of the Royal Society*, 1877, vol. 26, p. 248.

§ *Philosophical Magazine*, 1894, vol. 38, p. 365.

‖ *Ibid.*, 1894, vol. 38, p. 295.

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amount equal to the air density in a space exhausted to a very good vacuum. Also we appreciate an amplitude of motion of an air particle of 1 or 2 millionths of a millimetre and an energy stream of 1 to 3 micro-ergs or so per square centimetre per second.

It is obvious that a personal element of ear sensitiveness enters into these determinations of the pressure of the least audible sound.

It is not, therefore, surprising that very great differences appear between the results of different observers.

Thus Max Wien published a paper in 1903 "On the Sensitivity of the Human Ear for Tones of Various Frequencies,"* in which he gave the results of measurements made with a telephone receiver. He determined the maximum of the variable part of the air pressure producing just audible sounds of various frequency. Translating Wien's results into condensation and amplitude (maximum values) we have the following :—

Frequency, n	Condensation, S	Amplitude A
p.p.s.		
50	11.4×10^{-8}	117×10^{-7}
100	7.8×10^{-9}	4.2×10^{-7}
200	7.2×15^{-10}	1.8×10^{-8}
400	8.6×10^{-11}	1.13×10^{-9}
800	1.6×10^{-11}	1.1×10^{-10}
1,600	1.0×10^{-11}	3.3×10^{-11}
3,200	1.0×10^{-11}	1.6×10^{-11}
6,400	1.6×10^{-11}	1.3×10^{-11}
12,800	5.7×10^{-11}	2.3×10^{-11}

These figures show a decided maximum in ear sensitivity in the neighbourhood of the frequency 2,000 p.p.s.

Lord Rayleigh again returned to the subject in 1907, and in an article† on "The Relation of the Sensitiveness of the Ear to Pitch," he showed by a new method that the condensations corresponding to just audible sounds of frequencies, 85, 128, 256, 512, were in the ratio of 6.4, 3.2, 1.6 and 1.

He came to the conclusion that the ear had a maximum sensitivity at a frequency of about 1,000.

(5) Some recent researches aided by better instrumental appliances, and especially by the invaluable thermionic valve, have enabled this matter to be more fully explored.

(To be continued.)

ELECTRODE REACTIONS AND EQUILIBRIA.

A general discussion on this subject will be held by the Faraday Society meeting at the Institution of Electrical Engineers on Monday, November 26 next. The first session of the meeting will extend from 3 p.m. to 5 p.m., and will deal with "Conditions of Equilibrium at Reversible Electrodes." Sir Robert Robertson, president, will preside, and the Introductory Address will be given by Dr. E. K. Rideal. Among the speakers will be Professor Biilman, of Copenhagen, who will read a paper on "Some Oxidation and Reduction Electrodes and their Importance to Organic Chemistry." After an interval for tea, the meeting will resume at 5.30 p.m. and will devote itself to the consideration of "Irreversible Electrode Effects, including Passivity and Overvoltage." Professor F. G. Donnan, vice-president, will preside over this session, and the Introductory Address will be given by Professor A. J. Allmand. At the conclusion of the meeting a dinner will be held at the Holborn Restaurant, to be followed by an informal conference. Members of the Chemical Society, the Physical Society and the Institution of Electrical Engineers have been invited to attend this discussion. Others interested should apply to the Secretary of the Faraday Society, 10, Essex Street, London, W.C.2, from whom a full programme may be obtained.

* See *Pfluger's Archives*, 1903, vol. 97, p. 1.

† *Philosophical Magazine*, 1907, vol. 14, ser. 6, p. 596.

Questions and Answers by Practical Men.

RULES.

QUESTIONS : *We invite our readers to send us questions, preferably on technica problems that have arisen in actual practice. Questions which we consider of sufficient interest to our readers will either be replied to under "Answers to Correspondents" or replies will be invited from our readers. One shilling will be paid or the question which we select for competitive replies in this column.*

ANSWERS : *A fee of 10s. will be paid for the answer which we consider shows the greatest merit, and 5s. for the one we select as second best. In judging the replies, importance will be attached to clearness and conciseness, as well as accuracy. The Editor reserves the right to make no award, or to accept only one reply, if, in his opinion, the answers received do not possess sufficient merit. Competitors desiring the return of their manuscripts, if unaccepted, should enclose stamped addressed envelope.*

Write on one side of the paper only, and if diagrams are sent, draw them on a separate sheet of paper attached to the manuscript. Competitors may adopt a "nom de plume," but, both in the case of questions and answers, the competitor's real name and address must be sent with the manuscript as a guarantee of good faith. No correspondence will be entered into with regard to successful replies. The Editor's decision is final.

Commencing with Question No. 101, a Diploma of Merit will be awarded to the six competitors who win the first or second prize the most times during the next twelve months.

The words "Questions and Answers" or "Q" and "A" should be placed a the top left-hand corner of all letters intended for this column.

QUESTION NO. 171.

I have a 10 h.p. motor and the cone insulation on the vee rings has given out. How can I build this up again?—"A. C. WARNER."

QUESTION NO. 172.

Can any reader give working details of the method of producing power by means of motor generators for motion picture work? I require 75 amperes at 75 volts.—"CINEMA OPERATOR."

(Replies to Questions Nos. 171 and 172 must be received not later than December 1, 1923.)

Answers to Questions.

QUESTION NO. 166.

Can any reader give me details of a good electrical fire alarm system? I wish to instal it in a small workshop where the temperature is always varying owing to the intermittent use of a muffle furnace.—"TURNER."

REPLIES TO QUESTION NO. 166.

The first prize (10s.) has been awarded to "E. M. F." for the following reply :—

In reply to "Turner's" question, an electrical fire alarm system comprises an electric bell or horn to give audible warning, a source of current supply for the bell (often a battery of accumulators), and a special contact-making device inserted in the bell circuit, and arranged to close the circuit when the temperature of the surrounding atmosphere reaches a value which is considered to be indicative of fire. This temperature must depend to some extent upon local circumstances.

The bell and accumulator call for no special comment here, because such accessories are common to many

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other signalling systems, and Turner's chief interest at the moment will centre round the kind of contact-making device he is to adopt.

One kind of contact consists of two strips of different metals riveted together and bent in the form of a U, with one limb longer than the other. An increase in temperature causes the longer limb to bend inwards and make contact with a fixed contact point, thus causing the bell to ring.

Another system employs an airtight metal chamber, with one face made of very thin metal. The expansion of air inside the chamber due to high temperature causes the thin diaphragm to move outwards and make contact with a fixed contact, thus closing the bell circuit.

Now the conditions to be met in the case under consideration are somewhat onerous, because what may be quite a safe temperature when the muffle is at work, would very likely indicate a well-established fire if the same temperature should be reached at a time when the muffle is not at work.

Single-element alarms such as the foregoing would have to be set so as not to operate at the usual temperature attained with the muffle in use, otherwise the bell would ring continuously during working hours. This trouble could be surmounted by providing a separate hand-operated switch which would be opened when working with the muffle, so breaking the bell circuit and ensuring that the bell would not ring at times when the muffle would be at work.

A serious objection to this is its dependence on the human element. Any failure to close the hand-operated switch after closing down the muffle would mean that the alarm system would be totally inoperative.

A better arrangement would be to employ a contact with two elements, one of which could be set to operate at a lower temperature than the other. A suitable contact comprises a strip of thin metal *A*, slotted down the centre as shown in Fig. 1, and mounted on a cast-

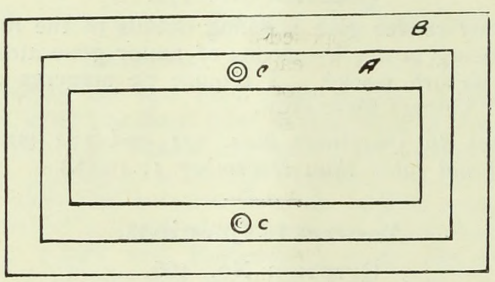


FIG. 1.

iron base *B*. It is, of course, insulated from the base. On each side of the slot a platinum contact point *C* is provided, and above each of these contact points is mounted an adjustible platinum-pointed screw, not shown in the sketch. When the atmospheric temperature increases above the normal the strips of metal each side of the slot expand outwards, and the platinum contacts will touch the points of the contact screws if sufficient expansion takes place, and thus close an electrical circuit. Now the contact screws can be set in such a manner that one side of the strip closes circuit at a lower temperature than the other, and it will readily be seen that one contact could be arranged to ring an alarm bell at a temperature which, whilst quite safe with the muffle operating, would be unsafe with the muffle not at work. The other contact would be adjusted to close circuit at a temperature which would be higher than that usually attained with the muffle at work.

The wiring diagram would be as shown in Fig. 2, in which *S* represents the strip of metal, C_1 and C_2 the contact screws, *B* a source of current supply, *A* the alarm bell, and *E* a single-pole hand-operated switch.

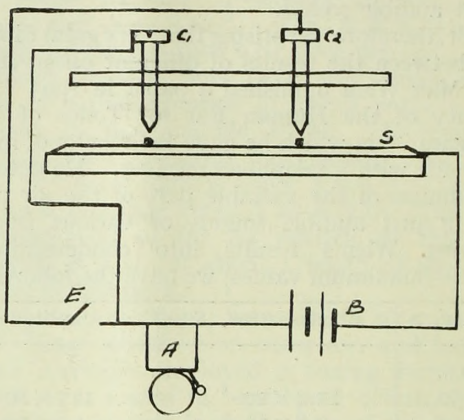


FIG. 2.

The single-pole switch is inserted in the low temperature circuit, and is opened when the muffle is at work to prevent the bell ringing continuously.

It is quite possible for the operator to omit to close the switch *E* after closing down the muffle, but this would not be so serious as with a single-element alarm contact, because the high temperature circuit is still left intact, so that in the event of fire the second circuit is sure to come into operation eventually.

Any number of these contacts can be wired in parallel to suit the circumstances. The wiring should be carefully erected and protected, and the contacts kept free of dust.—"E. M. F."

The second prize (5s.) has been awarded to S. J. Berryman, Gustavus Road, Camborne, Cornwall, for the following reply :—

Perhaps the following may be a help to "Turner" in regard to selecting a fire alarm.

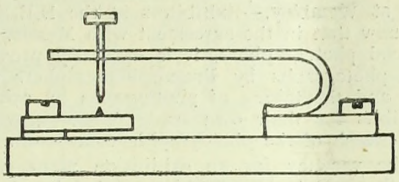
In one system a small-bore copper tubing is installed throughout the portions of the premises to be protected, and is coupled up to a central closed chamber, or series of chambers, each fitted with a flexible diaphragm carrying a contact-making device.

Increase of air pressure within the system set up by the local heating of the tubing at any given point raises the air pressure in the corresponding chamber. This forces the diaphragm outwards, thus causing the contacts to operate, and so complete an alarm-bell circuit. Provision is made for gradual expansion, such as would occur with the ordinary temperature changes during the day or night, or during the course of the seasons. This provision is in the shape of leak valves, which allow air to pass out of or into the system at such a rate that the alarm will remain unaffected, except for a sudden or abnormal rise in temperature.

The above described system is known as the "Aero" system, and is manufactured, I think, by Messrs. L. E. Wilson and Co., Manchester. Another system which is much more simple, and which "Turner" could make himself, is by means of a "thermostat."

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In the sketch we have a "thermostat" which consists of a metallic strip, and is adjustable to almost any degree of heat.



The contact-carrying strip is made of brass, and is riveted to an iron strip, the action being set up by the expansion and contraction of the two dissimilar metals.

At a temperature of 150 degrees F. the point is out of contact, but as the heat increases the strip bends inwards, owing to the difference of expansion of the two metals, and makes contact.

The thermostat should be connected up as a switch in an ordinary bell circuit. If it is desired to have more than one room on the system, one thermostat should be installed in each room, the whole being connected up in parallel to a bell and indicator, the indicator being in a room which is always in use.

DIESEL ENGINES.

There was a good attendance of members and visitors at the meeting of the Diesel Engine Users' Asocn., which was held on November 16, when Mr. Geoffrey Porter, Past President, read a paper on the subject of "Some Considerations Affecting the Choice of a Heavy-Oil Engine."

The author remarked that at the present time the choice of a heavy-oil engine suitable for the requirements of any given conditions was a far more difficult undertaking than would have been the case twelve years ago, as the number of types had increased so considerably. In 1911 one selected a 2- or 4-stroke cycle Diesel engine, and except for quite small powers there was nothing else available. The 2-stroke cycle engine at that time had not been very successful. Scavenging questions had not been so well understood as they were now, while the problem of proportioning the parts to the heat stresses had been solved in an empirical manner. Since then a vast amount of research into such matters had been carried out with the result that the 2-stroke cycle Diesel engine was now a formidable rival of the 4-stroke cycle pattern in the larger capacities. Side by side with the development of the Diesel engine had progressed that of the hot-bulb or semi-Diesel and the cold-starting types. The two latter were also keen competitors of the 4-stroke cycle Diesel engine. In addition there was the Still engine, in which the highest attained thermal efficiencies had been achieved, and the double-acting Diesel engine which was about to leave the strictly experimental stage.

The principal commercial types of engine available for land work were: (1) the Diesel engine, vertical or horizontal type, 2- and 4-stroke cycle, air injection, (2) the opposed piston Diesel engine, vertical, 2-stroke cycle, solid injection at various pressures according to type, from 2,000 lb. to 10,000 lb. per square inch, (3) the cold-starting solid injection engine, 4-stroke cycle, vertical and horizontal, and (4) the semi-Diesel solid injection engine, 2- and 4-stroke cycle, vertical and horizontal. Examples of these types and of their derivatives were to be found in power stations all over the world frequently side by side, and were giving satisfactory performances for precisely similar duties.

In selecting one or other of the types mentioned there were two principal considerations to be borne in mind:—(1) The efficiency of the engine, the term being extended to embrace materials, design, workmanship, rating and thermal efficiency, (2) initial cost and operating cost. An important element in the process of selection was the specification. In this document the purchasers' engineer must state his requirements and the local conditions clearly, concisely and rigidly. The specification must be drawn up on the widest practicable lines compatible with the services required as the manufacturer could only offer the type of engine which he had adopted as his standard, and manufacture to the individual idiosyncrasies of a multitude of engineers could not be conducted on a commercial basis.

The engines would differ among themselves in a range of suitable fuels, the specific fuel consumption and thermal efficiency, design, accessibility of parts, flexibility, lubrication, starting characteristics, capital and operating costs. The users' conditions would vary according to the site, the nature of the sub-soil, water facilities, space available, nature of the load, and neighbouring property.

The number of fuel oils capable of being used in heavy-oil engines was considerable, and the types of engine mentioned would all burn a wide range of fuel, though some called for modification for particular fuels.

Design was not usually a matter on which the user could speak authoritatively. He was in the hands of the manufacturer. High speeds, in the author's opinion, were not suitable for the operating conditions of power houses where long continuous runs were a common requirement.

Except with the opposed-piston type of engine, the provision of the crosshead was really a commercial consideration. The author looked upon the crosshead as a valuable insurance against damage to the moving parts of an engine.

When all was said and done, when the technical considerations had been weighed and the manufacturer had put forward a type of engine, robust, efficient, and embodying the very highest grade of workmanship (and a heavy-oil engine must be and was an extraordinarily well-finished machine), the final decision would depend upon the cost of operating under the conditions peculiar to the character of the purchaser's business. The author had prepared tables of operating costs for 1,500 b.h.p. of 4-stroke Diesel plant, 2-stroke semi-Diesel plant and 4-stroke cold-starting plant. The cost in each case was worked out at per b.h.p. hour, and included interest, repayment of capital and insurance.

B.E.X.—Though exhibits in next year's British Empire Exhibition are confined to British Empire products, in all but in name the exhibition will be international. Special endeavours are now being made to attract the foreign buyer to Wembley, and letters in nine languages are being sent all over the world telling the prospective visitor of the attractions of the fair. Great interest is being taken in the exhibition outside the Empire, and every day brings its quota of applications from the ends of the earth for information about the chief industrial event of 1924.

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WIRELESS.

The I.E.E. will hold a joint meeting with the Physical Society of London on Thursday next, the 29th inst., at 5.30 p.m., and it will be in two sessions, namely, 5.30 to 7 p.m. and 8 to 9.30 p.m. The subject will be "Loud-Speakers for Wireless and Other Purposes," and various other papers will be contributed as well as some practical demonstrations. By kind permission of the British Broadcasting Company arrangements are being made for parties, limited to 20 in number, to visit the Company's studio at No. 2, Savoy Hill at half-hourly intervals from 3 to 5 p.m. Members wishing to visit the studio are requested to send their names to the secretary and to indicate the time which would be most convenient to them.

Correspondence.

To the Editor of ELECTRICITY.

Sir,—We have to advise you that in response to a desire expressed by users of electric cable to be supplied with a cable intermediate in area between the standard sizes of .75 sq. in. and 1 sq. in., the members of the Cable Makers' Association are now manufacturing and listing, as a C.M.A. standard size, a cable of .85 sq. in. area (127/.093).—Your faithfully,

L. B. ATKINSON, Director,
The Cable Makers' Association.

November 19, 1923.

Various Items.

Wireless Agencies.—Dealers in wireless apparatus will be interested in the advertisement of the Liverpool Marine, etc., Insurance Co. which appears in another part of this issue. They are granting agencies to the trade in all classes of insurance business, and this is a side-line which is well worth careful consideration. We can therefore recommend our trade readers to write to the company and ask for full particulars.

China.—The report on the Industrial and Economic Situation of China has just been issued by the Dept. of Overseas Trade, nad may be obtained from H.M. Stationery Office or from ELECTRICITY Office, price 1s. 8d. post free. It contains a large amount of information of direct value to all engineering firms who have business relations with that great country Considerable extensions to plant have been carried out during recent years, and there should be a steady demand for electrical apparatus, which could be supplied by British manufacturers.

Meetings.—The Junior Inst. of Engineers will meet at 39, Victoria St., on Friday, the 23rd inst. Lecturette, "Technical Arbitrations," by W. A. Tookey, M.I.Mech.E. (Past-Chairman). Also on Friday, the 30th inst., lecturette "Notes on Design of Paraffin Motors," by Stratford C. Saunders (member). Both at 7.30 p.m.——The next monthly meeting of the Birmingham and District Electric Club will be held at the Grand Hotel, Colmore Row, on Friday, the 23rd inst., at 7 o'clock, when Mr. E. C. McKinnon, A.M.I.E.E., will read a paper on "Storage Batteries."

Safety Lamps Approved.—Lt.-Col. G. R. Lane-Fox, M.P., Secretary for Mines, announces in the Board of Trade Journal that on October 27 he made an Order under Section 33 of the Coal Mines Act, 1911, approving for use in all mines to which the Act applies, subject to the conditions specified in the schedule to the Order, the following types of safety lamps, viz.:—I.C.P. Lamps, Nos. 19A, 19FA, and 27A; Patterson Miners' Electric Hand Lamp, Type G.1A; "Kingsway II." Pillarless Electric Hand Lamp; Gray-Sussmann Electric Hand Lamps, Nos. 5 and 6; and "Ceag" Shaft and Roadway Lamp, Type B. The Order also amends the schedules to previous Safety Lamp Orders in respect to the specifications of certain types of safety lamps already approved.

A New-size Cable.—We would direct the attention of all contractors and wiremen to the letter from the Cable Makers' Association in column 1 of this page regarding a new size of cable which is now being placed on the market.

Photographs at Wembley.—Exhibitors at the B.E.X. will be interested to know that in the agreement with Messrs. Campbell Gray, the official photographers, it is expressly provided that the taking of photographs by Press photographers for Press purposes only, and the taking of photographs by exhibitors of their own exhibits for their own trade purposes, will not be regarded as a breach of the photographic concession.

Personal.—The vacancy for an exhibition manager recently advertised by the E.D.A. has now been filled by the appointment of Mr. W. A. Gillott, A.M.I.E.E., who is well known in the industry in connection with development work, the design and organisation of showrooms, domestic load-building and similar activities. All communications relating to the E.D.A. display at the British Empire Ehibition should be addressed to the Director of the Association, 15, Savoy Street, as usual.

Enterprising.—It is certainly a great pleasure to watch the keen enterprise and business ability which is being shown in regard to the work of the Electrical Development Association. New leaflets and circulars are being prepared and issued daily, and it is up to every electrical contractor, factor and engineer to make the utmost possible use of these E.D.A. leaflets, as it is by the skilful distribution of such literature that we can best aid the development of electricity in all its varied branches. We can but tender our most cordial congratulations to Mr. Beauchamp on the way in which he is making things hum generally.

Osram Christmas-tree Lamps at the Connaught Rooms.—This year London's leading hotels are making greater use of electricity for their Christmas decoration effects, a lead in this direction having been given by that well-known restaurant, the Connaught Rooms, who are decorating their tables for the Christmas season with the new Osram Christmas-tree outfits. These outfits, which consist of a number of the new Osram decoration lamps (of various colours), wired in series on flexible decoration strip, complete with adaptors for inserting in existing lampholders, make a very definite appeal for this class of work, owing to their adaptability and the extreme ease with which they can be fitted. They are, we understand, supplied for either low voltage (100-120 volts) or for high voltage (200-240 volts), and we can fully anticipate that the lead set by the Connaught Rooms will be largely followed by other restaurants and hotels.

Plant Wanted.—The N.S.W. Gov. Rlys. and Trys. invite tenders for the supply of motor-driven air compressors.——Also the Chief Electrical Engineer's branch invites tenders for the supply and erection of batteries for switch operating.——The Argentine State Oilfields Administration invite tenders for the construction of a central electric power-station of 15,000 h.p.——The N.S.W. Gov. Rlys. and Trys. invite tenders for the equipment of two sub-stations.——The N.S.W. Gov. Rlys. and Trys. invite tenders for the supply of motor generator sets.——The Electricity Dept. of the Municipal Council of Sydney invite tenders to be presented by February 18, 1924, for armour-clad switchgear.——The Post and Telegraph Dept. at Wellington, N.Z., invite tenders for the supply of 30,000 galvanised-iron earthrods.——The Victorian Govt. Rlys. invite tenders for the supply and delivery at the Railway Rolling-Stock Workshops, Newport, of one spring coiling machine with electric motor and one taper rolling machine with electric motor. Particulars from the D.O.T. (Room 52), 35, Old Queen Street, London, S.W.1.

The Commercial Motor Show.—At this most interesting exhibition, which opened yesterday at Olympia, there is clear evidence of the steady advance of the electric vehicle in public favour in this country for two main purposes—for short, heavy hauls in and around the town, and for the small platform trucks as may be seen at work on our railway stations. It is the simplicity of this type of motor-lorry which makes its appeal to the average man. Instead of a boiler and a steam engine, instead of a petrol engine, clutch, gearbox, etc., there is merely a small electric motor, driving the wheels of the motor by chain—just that and nothing more. The current for the motor is derived from storage batteries, exactly the same in principle as those used for the universally popular wireless. These batteries have to be charged once or twice a day, and that's all. At one stand there is an electric chassis with a curious driving gear, the casing of which has been fitted with windows so that its working can be watched, and, not to be outdone, a steam-wagon maker is showing some of the essential parts of his wagon in section. Altogether the show is one which should appeal to a very wide circle of our readers.

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A POPULAR SCIENTIFIC WEEKLY JOURNAL
ELECTRICITY
A PRACTICAL TRADE JOURNAL

NOVEMBER 30, 1923.

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TEACHING RADIO AT SEA.*

By Samuel Beach, C.R.M., U.S.N.,
Asso.Mem.A.I.E.E.
Instructor of Radio on the Battleship "Nevada."

An average of fifty men form the radio personnel of a modern super-dreadnought, and that is a conservative estimate. About half of this number are regular operators called "watch standers," and the others are students or "strikers for radio."

The strikers perform as messengers, mess attendants, compartment cleaners and so on, while training in the ship's radio school.

There should be approximately twenty-six full fledged operators to each ship. These men sign up for four years, have enlisted at different times, and there are always a number of "short timers" whose tours of service are expiring, so that there is always a pressing need of men competent to do the work.

There are a thousand and one minor ships, besides numerous shore stations, where it is impracticable to teach new men. The comparatively few graduates from land schools and recruits through enlistments and re-enlistments of finished operators can fill but barely 30 per cent. of the constant demand. So we have radio schools on board the big ships which must turn out the remaining 70 per cent.

After all is considered, it must be admitted that the sea-going radio student is far better fitted for the work when at last he dons the mischievous headphones and sits in on his first watch than is the best "boot" graduate from ashore, because he has been to sea, has got his "sea legs," learned a myriad of little necessities about a "battle-wagon," and has had months, while messenger, of invaluable radio communications "atmosphere" that no amount of lectures or reading on the banks of Lake Michigan can teach him. Besides this, he has performed real services while at sea—duties which otherwise have had to be done by others; he has paid his way. He is not a ward of Uncle Sam.

To the clean-minded boy who wants to learn, the Navy is just as anxious to teach.

And through it all there runs that scheme of play-time so essential to a healthy "kid." At every port of call there is liberty ashore—plenty of it. Foreign scenes are common. My own ship has within the past year visited Cuba, Brazil and Panama. The year before it went to Chile and Peru. Next year it may be China. We are always on the go.

In Naval radio communications there are two prime factors which are taught aboard ship, transmitting and receiving, and "procedure," which is the how, why and when of it all.

There are three classes of students as a rule. One is for beginners who are given a few hours each day at plain sending and receiving the code, by means of an ordinary key and buzzer.

The matter used is never taken from newspapers or other "straight English" stuff, but consists instead of four- and five-character combinations of mixed letters and numerals—the most difficult because there is no possibility of guessing or anticipating what the next word or the next letter will be. Try a hundred groups on your own piano if you please, like these:—

Z7NNA—TEE15 AU4V4—XQY73—10/3/23—73S29—ZVUJ9—S6S5H—DB6B6, etc.

When a student can take five or six groups a minute perfectly he enters the Intermediate Class, where his speed increases, and he begins to hear lectures on dreaded procedure.

The test of speed in vogue in the Naval radio service may seem fallacious to the old-time telegrapher with his standard of thirty words a minute, but experience proves its worth, nevertheless.

A Navy radioman who can receive and neatly print with a pencil twenty words per minute of test character code is exceptionally talented.

A man must be able to send and receive the test without a single mistake for the following lengths of time according to the operating speeds:—

Less than 15 words per minute for 3 minutes.
Less than 20 words per minute for 4 minutes.
More than 20 words per minute for 5 minutes.

The sending and receiving speed of a man who has met the specified time requirements is determined by adding the characters received, and dividing the result by the number of minutes multiplied by five. So a man who correctly receives 400 mixed letters and figures in 4 minutes has attained a speed of twenty words a minute, as per the following calculation:—

$$\frac{400}{5 \times 4} = 20$$

All of the full-fledged radiomen aboard ship attend the Senior Class when the hours do not conflict with their regular duties. This class continually pounds away at the code, perfecting its "copies" and its "sending." Then they are formed into Fleet Battleship Divisions, each man representing and answering to the call of some actual ship. By this means they practise fleet radio manœuvring signal procedure until they become expert. This work is made especially interesting by lectures explaining just what each ship or unit of ships

* *Telegraph and Telephone Age*, New York.

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would do upon receiving such orders. Indeed, the great grey bloodhounds of steel "squad right," "about face" and "column left" even as soldiers do. But the Doughboy from "Over There" would never recognise their old familiar commands in the mess of dots and dashes sent in their stead by radio. I regret that Naval regulations forbid an extended explanation of radio fleet manœuvring. It is intensely interesting.

Unfortunate married folks who exist in West Coast "upper crust" apartments may readily appreciate analogous conditions on board a crowded man-o'-war. They push their beds out of sight through the wall, the sailor stows his hammock out of sight; they daintily slap a handy push-button and a dining table comes forth from where grandma's crayon portrait was hanging, the sailor's mess table "when at rest" hangs out of the way overhead, and so forth. It is plain, then, that our radio class on shipboard must use apparatus that is portable, so that the classroom space may be used for other purposes at any moment. To this end the battleship *Nevada* uses five telegraph keys wired in parallel on each of two thin hardwood boards 10 in. wide by 5 ft. in length. Each key may be used by two students. At the end of one board is the instructor's key. The two boards may be quickly connected, and any key will work the one buzzer that is on the instructor's board. To this buzzer is connected a loud-speaker horn. The boards are set on tables for use. A 6-volt storage cell furnishes current. The entire outfit may be set up or taken down and stowed out of sight in less than a minute.

Besides practice and procedure studies in class the radiomen, while standing regular watches, are given a drill lasting about an hour once every four hours, day and night, year in and year out, while the big vessels are at anchor. The ships alternate in sending this drill to the other ships of the respective divisions. It is perhaps needless to add that Uncle Sam's radio forces may be confidently relied upon should occasion arise. They will do their bit, and do it to a queen's taste.

Promotion is positive in the radio branch for every man proving that he wants to succeed. It is surprising how many, instead of wasting their time as the general public very wrongly understands, engage in special studies. This is true throughout the Navy. In my own section, comprising forty radiomen and strikers, aboard the *Nevada*, one man studies law, one studies chemistry, and fifteen are enrolled in other courses, principally electrical engineering. That shows the "pep" that our radio crews are made of. The ship's officers want to help such men, and take pains to do so.

In my capacity as an instructor I am in close contact with enlisted men of all branches, watch the inevitable broadening of their minds by travel, and know the gratifying physical improvement incident to fair discipline, necessary cleanliness, substantial food and personal instruction. They are good, honest American kids when they enlist; they are strong, clear-minded men in every way ready to make a living for themselves when they leave the service. And there is that fine, distinctive, Naval bearing that they evermore wear with honour to themselves and credit to the fraternity of the sea.

The Junior Inst. of Engineers.—On account of the General Election, the meeting announced for Friday, December 7, 1923, at the Royal Society of Arts, has been postponed to Wednesday, January 16, 1924, at the same hall.

"MAGNET" HEATING AND COOKING APPLIANCES.

As our readers may be aware, there are two methods of conducting a sales campaign, the intensive and the extensive. In the first instance, one definite goal is aimed at, and all the forces of the sales organisation concentrate on that one particular point. In an extensive campaign the forces march upon a much wider front, the effort is general rather than particular, and, provided that sufficient weight is behind the effort, steady progress is inevitable.

The General Electric Co., Ltd., have decided upon an extensive campaign to sell "Magnet" electric heating and cooking appliances this season, the basis of this effort being the issue, on a very liberal basis, of up-to-date catalogues, giving descriptions and prices of all "Magnet" specialities, and the broadcast distribution of a series of 16 folders, each dealing with some particular aspect of electric heating or cooking. In addition there are two comprehensive catalogues.

The first, section H (1), 16th edn., deals with fires, a variety of models in sheet metal, art metal, earthenware, and cast-iron being shown. An interesting feature is the series of reflector fires, commencing with the well-known Pedestal Heater, and dealing with other forms in which heat from glowing coil elements is reflected forward by a back screen of polished copper, designed to give the heat distribution required. Fig. 1 shows a typical fire of this type.

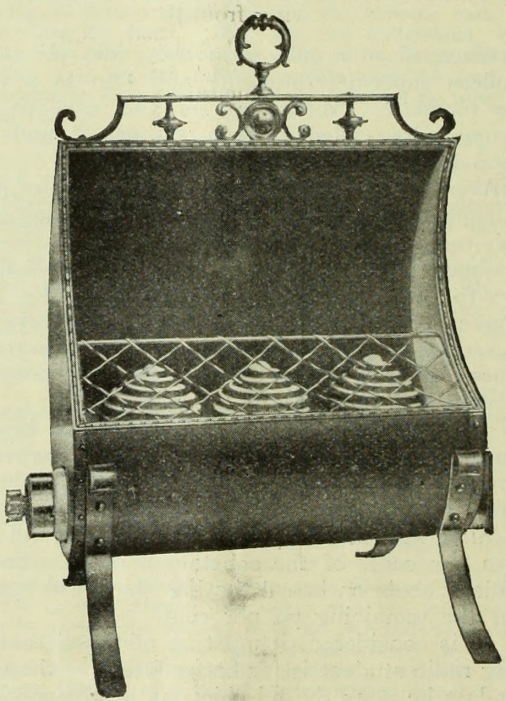


Fig. 1.—"Magnet" Reflector Fire. Maximum Loading 3 Units.

The second new catalogue is section H (2), 14th edn., dealing with cooking appliances, devices such as sterilisers, saucepans, urns, kettles and toasters, are listed in great variety, and a comprehensive section deals with "Magnet" cookers. Of these a good design of portable cooker, with a maximum loading of 2,700 watts (illustrated in Fig. 2), is constructed of stout

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sheet metal mounted on a rigid angle-iron frame, and double cased. The interior is fitted with the usual grid shelves, baking tin, grill bars, etc., and three heating elements are fitted. Two of these are side elements for

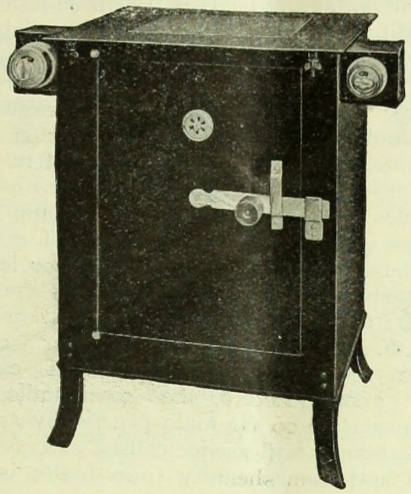


FIG. 2.—"MAGNET" SHEET METAL COOKER FOR 6 PERSONS.

oven heating, and the other is a top element, which is used not only for oven heating, but as the grilling element and as the element for the hot-plate above. Two three-heat switches are fitted, thus allowing 15 different heat controls, varying from the maximum consumption of 2,700 watts down to 300 watts only. The cooking space is $17\frac{1}{2}$ in. by $10\frac{1}{2}$ in. by $12\frac{1}{2}$ in., and the oven will perform every culinary operation required by the average family of 4 to 6 persons. A feature is that by unscrewing a few wing nuts the whole of the electrical equipment can be immediately removed, and the cooker body left free for cleaning. Fig. 3 shows this cooker dismantled, as described.

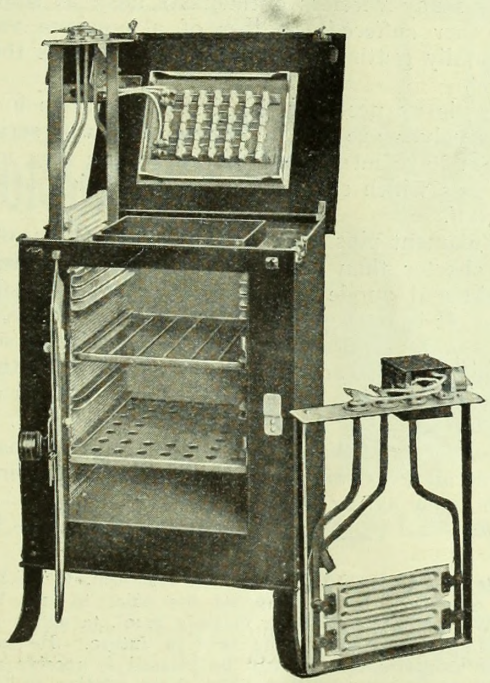


FIG. 3.—"MAGNET" SHEET METAL COOKER DISMANTLED.

The final section of the catalogue is devoted to "Magnet" irons and various industrial applications of electric heating, among the novelties being a new millinery iron, illustrated in Fig. 4.

Among accessories is included the convenient "Magnet" two-way adaptor, which enables small devices such as irons, kettles, etc., to be used from an ordinary lamp-holder without interfering with the lighting of the room. There is also a switch connector designed to fit the standard pin terminals of all "Magnet" appliances with self-contained push action switch and spring flexible cord protector.



FIG. 4.—"MAGNET" MILLINERY IRON.



FIG. 5.—HAT BRIM ATTACHMENT FOR MILLINERY IRON.

A note on the last page of the book reminds us that the G.E.C. are prepared to design heavy cooking equipment suitable for use in hotels, restaurants, canteens, etc. A new Bulletin, No. 21, has been published to deal extensively with this subject.

We have already stated that these catalogues have been distributed lavishly to the electrical trade. They are supplemented by a useful series of 16 folders, each dealing with some particular type of "Magnet" electric heating or cooking appliance, and these are available for overprinting with dealers' names and addresses for distribution to the public.

We are asked to state that copies of the catalogues and folders will be willingly supplied to those interested upon request, either to Magnet House, Kingsway, or to any of the G.E.C. provincial branches.

THREE-PHASE SUPPLY TO SINGLE-PHASE NETWORKS.

BY G. W. STUBBINGS, B.Sc.

In the early days of electricity supply the single-phase A.C. system was largely used. The possibility of generation at 2,000 volts, and the ease and economy with which electricity could be transformed to low voltages suitable for domestic supply, made the system an attractive one for districts of a residential character where the load was then almost purely lighting. In spite of the fact that some of these single-phase networks were later changed over to D.C., in order the better to cope with power requirements, the majority have persisted, and are still found eminently suitable for their purpose. The improvement in the economy of modern generating plant is, however, rapidly rendering the old alternators obsolete, and with the introduction of modern machinery it usually is advantageous to generate on the three-phase system. This enables new demands to be dealt with according to up-to-date practice, is favourable to power supply in newly developing districts in the area of supply, and involves the cheapest alternator construction.

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Since there is no way available without the use of revolving machinery of supplying from a balanced three-phase supply, a single-phase demand, the direct connecting of the old single-phase networks to the new three-phase generators would involve serious unbalancing. This would largely diminish the available output of the alternators, for this output would be fixed by the heaviest loaded phase of the machine, and further, the armature reactions caused by an unbalanced single-phase load of any magnitude occasion additional losses unless special safeguards are provided.

It, therefore, becomes necessary to divide the old single-phase network in such a way that it takes from the three-phase generators an approximately balanced load. The division can be made into three parts, in which each part is supplied from one phase of the alternator, or into two parts which are supplied from a three- to two-phase transformer.

The latter of these schemes is the most usual. If the generating voltage is 6,600, then in any case transformers would be required to supply the old 2,000 volt network, and the additional complication of Scott connected banks is not important. The great advantage of the two-phase method lies in the possibility of so arranging the division of the old networks as to reduce to a low figure the number of the existing section points —either in substations on the 2,000 volt system, or in network boxes on the low-tension system—that are out of phase. The presence of these out-of-phase sections, even if precautions are taken, is objectionable, and it is advisable to reduce them as far as possible. On the other hand, as emergency linking-up points, they can still be used provided care is taken to make one side dead before bridging across—so that it would be a pity to abolish them, and leave additional dead-ends on the network.

The number of these danger points will necessarily be greater if the three-fold division is used, and this constitutes a potent argument in favour of the two-phase system. Further, the possibility of an equitable division as regarding loading will also be greater with the two-phase system—it being remembered that the division should be such as to be well balanced at all times of the day and not merely at peak time.

The cost of transformers rather favours the three-phase system. The delta-star system can be used, the 2,000 volt side being four-wire. If the load division be good the k.v.a. capacity of the transformers will be capable of supplying a corresponding external k.v.a. load. With Scott connected transformers it will be remembered that the main transformer, which is connected across two of the lines on the three-phase side, is working at only 0.86 power factor, with unity power factor load, and that consequently this transformer will not be competent to supply the rated k.v.a. to the secondary side. Further, since the two transformers are usually similar, the teaser transformer using an 86 per cent. tap, the ratio of available k.v.a. to rated k.v.a. will be 86 per cent. for the whole bank. This circumstance is not, however, of great importance, and the advantages of the two-phase supply usually outweigh it.

There is a further advantage of the two-phase system which may be mentioned. This is the possibility of giving a two-phase supply to new customers at certain parts of the network. Where two high- or low-tension mains connected to different phases are available, it will obviously be possible to give a two-phase supply, which, for power purposes, is as advantageous as three-phase. This possibility may be sufficiently common with the two-fold division of the network to be a real advantage, but with the three-fold division, the possibility of having three phases available in one spot is obviously very much less.

Mention has been made of the satisfactory way in which many of the old single-phase networks are behaving, and a few words might be added as to the great advantages of the single-phase system for small domestic consumers. Experience has shown that concentric cables used on single-phase systems are more reliable than probably any other class of distributing cables. The fact that the outer conductor is at earth potential means that the live conductors are virtually separated by a double thickness of insulation from the lead sheath. The joint boxes for concentric cables are small and compact, and can, with reasonably good jointers, be so installed as to leave the insulation of the main practically as good as before. Both main and service cables, and also fittings, are cheap, and the immunity from faults is remarkable. For local H.T. distribution, the single-phase system has the great advantage of simplicity of switchgear and control apparatus in that, working with one pole solidly earthed, H.T. switchgear required is of the single-pole type.

The disadvantage of the single-phase system for a considerable power load still remains, but recent advances in the design of single-phase motors renders it possible to deal with any kind of small power demand quite successfully, the only outstanding disadvantage being in a slightly increased first cost as compared with plant of similar output for a D.C. system.

A REAL "FOOL-PROOF" VALVE CAP.

How many wireless enthusiasts have at some time or another suffered the loss of a precious valve by accidentally getting the filament pins across the H.T. supply?

There is no need for this danger to arise in future if your valves are of the famous Ediswan series, for this firm have introduced a simple little idea in these valve caps which can be described as being absolutely fool-proof.

The filament pins are cut off at unequal lengths, one being shorter than the other, and both shorter than the grid and anode pins, which are of the standard length. It is thus quite impossible to make accidental surface contact with the grid or anode circuit sockets, and the filament cannot go into circuit until the grid and anode pins are pushed well home in their correct sockets.

We understand that this little idea has been patented and that all Ediswan valves will in future be provided with this new safety cap.

Change of Address.—Mr. Haydn T. Harrison, M.I.E.E. (consulting engineer), has transferred his office to 14, Victoria Street, Westminster (telephone Victoria 3719), to which address all communications should be sent in future. He has also asked us to notify that he will be pleased to receive all new issues of catalogues, etc., especially those relating to lighting, which may not have been previously sent to him.

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WESTON ELECTRICAL MEASURING INSTRUMENTS

PORTABLE D.C. INSTRUMENTS.

Weston Portable Direct-Current Model 45 Instruments are designed to meet the demand for a low-priced portable instrument of sufficient accuracy for Station work and general testing.

The movement of this type of instrument is completely enclosed in an iron case (which protects it from stray magnetic fields) securely fastened in a wooden carrying case, provided with a carrying handle and a hinged cover to protect the scale and binding posts. It is fitted with a knife-edge pointer, working over a mirror under the scale to eliminate error in reading due to parallax and possesses a very light moving system. It will withstand a large amount of rough handling without developing pivot friction or becoming unreliable.

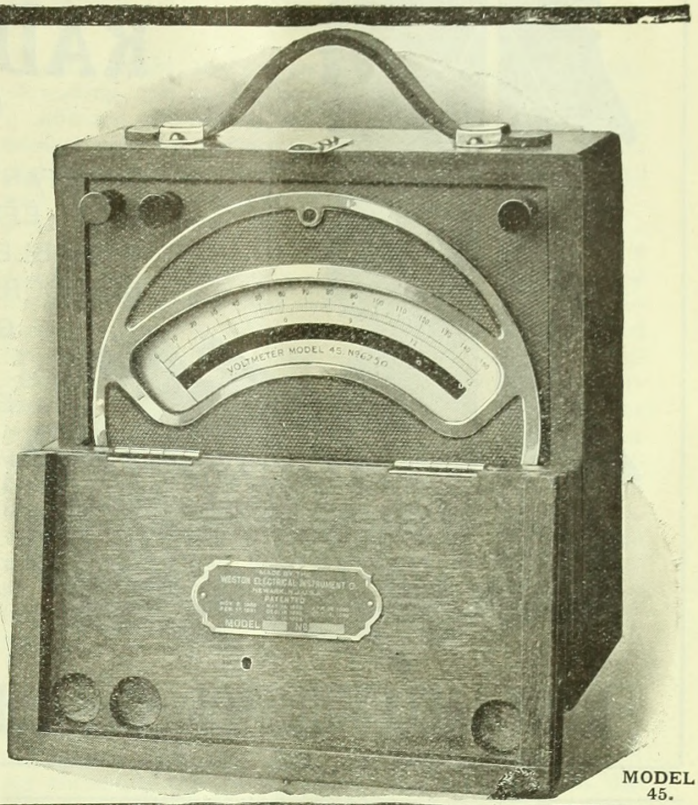
These instruments may be supplied with self-contained shunts for certain ranges, and are supplied as voltmeters, ammeters, milli-voltmeters, and mil-ammeters, or volt-ammeters of any ranges desired.

They are designed for all work in which the accuracy of our Model 1 is not desired, and owing to their excellent design, construction, and long life are cheaper than any other instruments offered for similar service.

Write for full particulars.

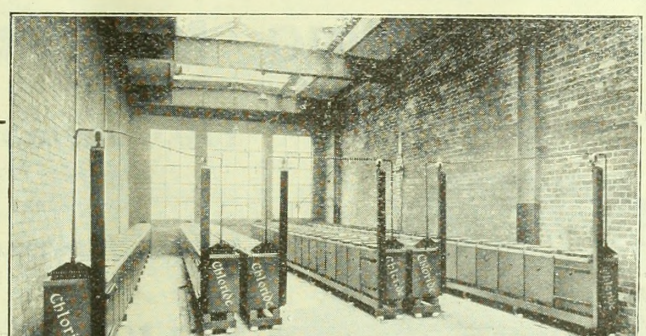
WESTON ELECTRICAL INSTRUMENT CO., Ltd.,
Audrey House, Ely Place, Holborn, London, E.C.1.

Telephone: Holborn 2029.
Telegrams: "Pivoted, Smith, London."

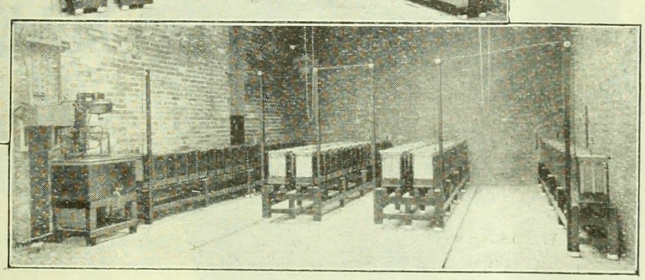


MODEL 45.

STORAGE BATTERIES AT BARTON POWER STATION.



No. 1.



No. 2.

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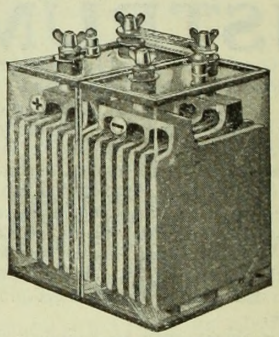
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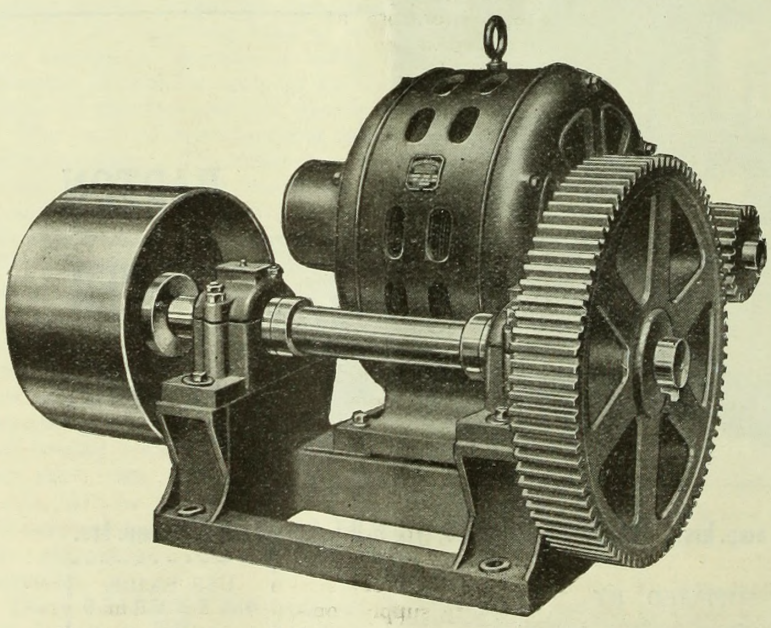


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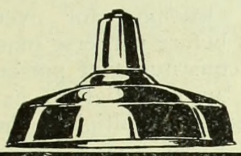
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Current Topics.

The Breakdown Season.

During the past month electricity supply failures have assumed regrettable proportions, many provincial towns being affected, in addition to certain districts of the metropolis. Heywood, Leeds, York, Coventry, Barrow, Brighton, Leicester, Glasgow, Bloomsbury, Durham, Hull and Liverpool all experienced this inconvenience in varying degrees of intensity. In some instances the tramway services were affected as well as public and private lighting, and, taken in the aggregate, the total of inconvenience, danger, and loss of prestige to electricity supply as a whole must be considerable. My personal experience was confined to the All-British Wireless Exhibition at the White City, Shepherd's Bush, where I happened to be on the evening of the closing day. Just about an hour before the Exhibition finally closed a main fuse went, and all the stands on one side of the main hall were left in darkness for upwards of half an hour, an inordinately long period for the replacement of a fuse.

Fortunately the public had thinned out, as they usually did towards 9.30 p.m., and the hall was comparatively empty. Stall attendants promptly policed the front of their stands and awaited a resumption of the illumination. Had the incident occurred early in the evening of one of the crowded Saturdays, when police were necessary to marshal the crowds in the principal aisles, there would doubtless have been much disorder and loss of valuable property on the part of the exhibitors. In the circumstances it would appear desirable to instal alternative and automatic lighting systems as a stand-by wherever places of public resort are liable to electricity supply failures. In this connection I note that certain of the London Underground railway coaches have small stand-by lighting fittings which light up immediately the main lights fail through imperfect rail contact or when passing insulating points.

In Liverpool, the last recorded failure up to the time of writing, the trouble was more serious, inasmuch as it affected the entire city's tramway service at the busiest hour of the morning traffic when business men and office workers rely upon this means of getting to and from their offices. The breakdown, which happened shortly after nine o'clock in the morning, was due to the fusing of a high-tension transformer and switch-gear at the main power station. This caused an outbreak of fire, and cut off the power supply over a very wide area. The fire was quickly extinguished by the fire brigade, using sand and chemical extinguishers, but the supply of current was not fully restored until about half-past ten. This particular breakdown serves to emphasise the danger of relying upon one single means of transport for the entire population of one of our largest provincial cities. Failing the electric tramway service, which is itself by no means efficient or sufficient for the city's needs, the workaday population is left with no alternative means of travelling, and in such cases as this very heavy losses of time, money, and business must necessarily result.

Brighton put up the unenviable record of two successive breakdowns in less than a fortnight, affecting the town's lighting. The first failure, which lasted for three-quarters of an hour, was attributed to the fall of an iron door on to some high-tension terminals, causing a short-circuit. The cause of the second breakdown, which lasted for half an hour, and paralysed the tramway service as well as lighting, is unrecorded up to the time of writing. Industrial Coventry is handicapped by the burning out of one of the main generators at the local power station. This has involved serious overloading of the remainder of the available plant, and, as a result, local manufacturers who use the city's electrical energy have been requested to assist in levelling out the peaks in the power load by extending their night shifts, and reducing the duration of their day shifts as far as possible until additional plant can be installed to cope with the situation. The failure in York, the second in a year, is attributed to cable breakdown, and has been adversely criticised in the local Press.

Prevention is better than cure, and although some of these causes of breakdown are difficult to foresee and guard against, supply station engineers should be on the qui vive to detect any incipient weaknesses in the systems under their control, and take the earliest opportunity of replacing or renovating doubtful plant or mains. The alarming frequency of these supply failures is tending to neutralise the strenuous efforts of the E.D.A. to popularise electric service. It should be remembered that every serious or sustained breakdown of electricity supply constitutes an enormous and widespread advertisement in its disfavour. Reliability is the keynote of sustained and increasing popularity; once lose public confidence, and it is doubly difficult to regain.

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Propaganda of the Wrong Kind.

From time to time I have animadverted on the pie-crust promises of would-be municipal councillors just prior to the municipal elections. A striking example of the mischief wrought by such ill-considered propaganda, and, incidentally, a practical example of the fallacy of municipal profiteering, is to be seen at Hull, where a strike of the municipal electricity workers has just been narrowly averted. In consequence of boasts made during the election campaign that Hull Corporation was making a profit of £100,000 on electricity supply, workers in the department threatened to strike for an advance of one penny an hour. On learning that they had been misled, however, and that the actual profit was of the order of £3,000, they withdrew their demand. I have always contended, and I think rightly, that a municipal trading department has no right to make large profits and allocate them to the relief of rates.

Looking Ahead.

Such departments are the property of the ratepayers as a body, and run for their collective benefit and convenience. Any appreciable margin over working expenses, after extensions of plant and buildings, sinking fund, interest on and repayments of loans, etc., should be applied to a general reduction in the price of the commodity sold, in this case electrical energy. There is no case for the claims to relief of those ratepayers who are not at the same time consumers of municipal electricity, and the actual users and supporters of the system should reap the major benefit accruing from any economies in generation and supply. Furthermore, municipal accounts are, or should be, public, and it is only natural that those who have helped to bring about such successful results, in this case the electricity supply department's staff, should expect a share in the fruits of their endeavours. A successful undertaking, having brought its generating costs down to a popular figure per unit, could well afford to give its most deserving employees some slight benefit as a reward for their share in the result.

That some Sussex urban councillors are fully alive to the possibilities of the immediate future may be gauged from the fact that in discussing the terms of a contract for the supply of electricity for lighting the streets of a certain Sussex village, a questioner, thinking of the possibilities of a wireless transmission and distribution of power, asked that a saving clause be inserted in the proposed contract to the effect that should science find some better way of lighting the streets within the next ten years the place would get the benefit of it. The suggestion was agreed to and the clause duly inserted. One never knows in these progressive days what epoch-making discovery is coming along to-morrow which may alter the whole course of electric light and power distribution as we know it to-day.

Science and Progress.

There is a certain school of thought that regards science as a ruthless and destructive force, pointing to the havoc created by scientific implements of warfare. Sir Richard Gregory, in a very able address before the Circle of Scientific, Technical and Trade Journalists, on November 20, pointed out the injustice of this view, as expressed by Ruskin, George Gissing and other writers. Naturally, warfare becomes more destructive when the powerful aid of science is invoked; but how much vaster are the benefits that science, when wisely used, has conferred on mankind!

Industrial Advances.

Even the discoveries most closely identified with war have had far-reaching peaceful applications. Chlorine was used for bleaching for over a hundred years before perverse man utilised it as a constituent of poison gases. Nitre, an essential to explosives, in the form of fertiliser has multiplied the productiveness of the soil. The great textile industries of Great Britain are based on scientific discovery. Coal and minerals would have remained as buried treasure but for the invention of the steam engine.

Future Developments.

It is equally absurd to blame science for the sordid aspects of industrialism, due to the misjudgment and shortsightedness of mankind. Science is constantly making contributions which alleviate the lot of the worker. No discoverer can foresee the applications of his work. In any case, it is futile to try to stop the march of science. It is possible that we are now on the eve of discoveries which will release forces and convey powers far greater than any realised in the past. Let us, therefore, be on our guard, and determine to use these gifts of science in such a way that they prove a blessing and not a curse.

ELEKTRON.

THE UTILISATION OF COKE BREEZE.

One of the most difficult fuels to burn efficiently for steam generation is coke breeze, especially when in a very fine state of division. As is, of course, well known, this material has a comparatively high heating value, often 10,000 B.Th.U. per lb., but in addition to the natural difficulty of ignition because of the low volatile content, there is added that of the small and light particles of which it is composed. Thus, for example, if an attempt is made to burn such material mixed with coal in, say, chain grate stokers, it either falls between the links of the stoker and enormously increases the problems of riddling, or, in the case of strong draught, is blown off the bars.

As a consequence literally millions of tons of this product are thrown away as a waste product and vast mounds of it exist in many parts of the country. The same troubles, of course, occur in connection with cylindrical boilers. That it can be burnt, however, at a high efficiency has been proved by the "Turbine" steam jet forced draught furnace with their new adaptation of "slot" elements. It will be remembered that the ordinary "Turbine" furnace consists essentially of a number of longitudinal trough steam jet fire-bars containing 40 or 50 small transverse fire-bars or "elements" having between them a $\frac{1}{8}$-in. air slit. For the burning of difficult fuels, such as coke breeze or anthracite duff in a fine state of division, these elements have now been replaced by a special type having instead eight or nine tiny air slots, and so designed that it is impossible for the material to fall through. As a consequence, the forced draught blast

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necessary for efficient combustion is so sub-divided, the surface of a 6 ft. grate of a Lancashire boiler containing over 2,000 of these slots, that the material is not blown off the bars.

Thus, for example, on standard "Lancashire" boilers, an evaporation of 5.7 lb. of water per lb. of fine coke breeze is being obtained in this way, whilst the evaporation is about 6,000 lb. of water per boiler per hour, corresponding to approximately 75 per cent. of the average performance with good coal. Also, if a mixture of two parts of breeze and one part of coal is used, the results are easily equal to the best class coal with natural draught, evaporating about 7,500 lb. water per boiler per hour.

The point is, therefore, in any town having an electricity station and a gas-works, and especially a coke-oven plant, it is a proposition well worth considering to install one or two Lancashire boilers, or, say, a small water tube boiler with grates not over 7 ft. in length, to burn efficiently all the coke breeze for the generation of electricity.

ELECTRICAL ENGINEERING—FINAL GRADE.

SOLUTIONS TO 1923 EXAMINATION QUESTIONS OF THE CITY AND GUILDS INSTITUTE.

BY EDWARD HUGHES, B.Sc. (Eng.), A.M.I.E.E.

(*Continued from page* 593.)

Q. 10.—Describe a commercial form of electrical steel furnace, stating the approximate energy consumption per ton, the working voltage and method of regulation.

A. 10.—The majority of electric steel furances at the present day employ the electric arc in one form or another, and operate off an A.C. supply. One of the most recent examples of the electric steel furnace is the installation at the Fiat Works in Turin, an account of which appeared in the *Electrician* for September 21, 1923. These furnaces have a capacity of 15 to 20 tons

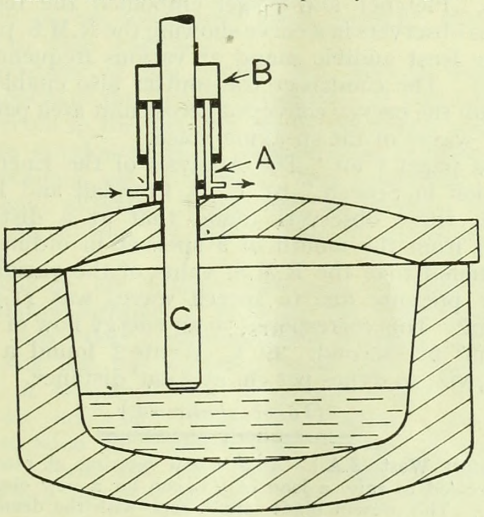


FIG. 15.

and work off a three-phase supply. The principal improvements incorporated in these furnaces is the mounting of the electrodes. The principle is shown in Fig. 15, where *C* represents one of the three graphite electrodes, 35 cm. in diameter, to which is clamped a cylinder, *B*, fitting closely around and capable of moving telescopically over a water-cooled jacket, *A*, the latter being fixed to the roof and fitted with inlet and outlet pipes at the lower end. By this means the air is prevented from entering the furnace, so that the burning of the electrodes is reduced to a negligible amount and their life consequently increased considerably. The arrangement also has the advantages of reducing the heat losses and the energy consumption and of maintaining the inside of the furnace neutral, so that the carbon in the metal is not oxidised.

The three electrodes are carried by a special bridge over the furnace, and their position controlled by three electric motors which can be operated either by hand-controllers or by automatic regulators through current transformers.

The furnace is so arranged that by slight tipping the slag can be drawn into a container under the charging floor. Also, the opening for the charging door has a water-cooled frame on the outside to protect the cover during charging.

The time taken for melting and refining is less than 2½ hours, even when starting with a cold charge. During the melting period the furnace voltage is 130 volts, but this is reduced to 75 volts during the refining period. The furnace is supplied through a transformer which is connected delta-star during the melting period. The lower voltage of 75 volts is obtained by changing the primary over to star. The star point of the secondary is connected to the shell of the furnace and also to earth.

The average consumption for these furnaces has been found to be about 670 kilowatt-hours or Board of Trade units per ton of charge. This figure is inclusive of the losses in the transformer.

(*To be continued.*)

PROBLEMS IN TELEPHONY, SOLVED AND UNSOLVED.*

BY PROFESSOR J. A. FLEMING, M.A., D.Sc., F.R.S.

(*Continued from page* 635.)

It is abundantly clear from this later work that the human ear possesses a well-marked supersensitivity to sounds of certain frequency. One of these regions generally lies within the limits 700 to 1,000 p.p.s. and another between 1,500 and 2,000 p.p.s., and some observers indicate a third region about 3,500 to 4,000 p.p.s. There are, however, considerable variations in normal ears in this respect. This has been well shown in a paper † by J. P. Minton on "Physical Characteristics of Normal Ears."

He employed a telephone receiver with a diaphragm having a very high natural frequency (5,215 p.p.s.) and placed it in the bridge circuit of a Wheatstone's bridge supplied with alternating currents of pure sine wave-form by means of a thermionic-valve generator with appropriate frequency filters. He calculated from the observed constants of the telephone the vibrational energy of the diaphragm for various bridge settings, and the sensitivity of the ear was taken to be inversely as the vibrational energy when the telephone was emitting a just audible sound at a certain

* Lecture delivered before the Institution of Electrical Engineers, to whom we are indebted for the illustrations.

† *Physical Review*, 1922, vol. 19 (2), p. 80.

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frequency. He found as above mentioned that there are well-marked regions of supersensitivity in normal ears for certain frequency ranges.

The ear sensitivity diminishes very rapidly as the frequency rises much above 4,000 or 5,000 p.p.s. Thus, C. E. Lane,* using a particular type of sound producer called a "Tone Generator," invented by C. W. Hewlett,† found that at a frequency of 2,000 p.p.s. the just audible sound to normal ears conveyed in wave energy 0.07 micro-erg through each square centimetre per second, but that when the frequency was raised to 18,000 or 20,000 it required an energy stream of 0.1 erg per square centimetre per second or nearly 1½ million times as much power to produce the just audible sound.

A very complete examination of this question was made in 1922 by H. Fletcher and R. L. Wegel in a paper ‡ on "The Frequency-sensitivity of Normal Ears," working in the research laboratories of the American Telephone and Telegraph Company and of the Western Electric Company, U.S.A. They used an air-damped telephone receiver and passed through it various pure sine-wave currents supplied by a thermionic-valve generator. The generator had its current filtered so as to eliminate all harmonics and produced an absolutely pure tone. This is an important precaution, because a tone at 100 frequency requires 60 times greater pressure variation or 3,600 times greater energy to be just audible than a tone at a frequency of 1,000. They also constructed a particular form of artificial telephone line by which the current passing through the receiver could be weakened in an exactly known ratio. As a means for absolute calibration they used a condenser transmitter. This instrument is an improvement and modification of Dolbear's electrostatic transmitter. It consists of a fixed, solid, perfectly flat plate in front of which and parallel to this but about one-thousandth

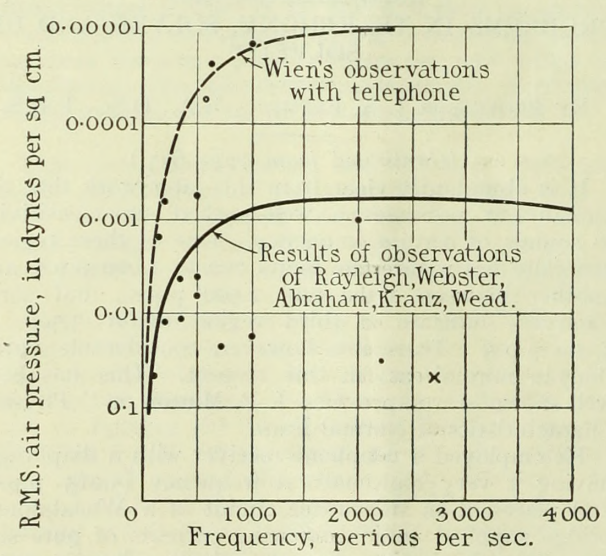


FIG. 1.—CURVE SHOWING BY ITS ORDINATES THE ROOT-MEAN-SQUARE VALUES OF THE VARIABLE PART OF THE AIR PRESSURE IN AN AIR WAVE PRODUCING A JUST AUDIBLE SOUND, PLOTTED IN TERMS OF FREQUENCY.

NOTE.—The cross indicates the result obtained by Lord Rayleigh in his experiment with the whistle.

* *Physical Review*, 1922. vol. 19, p. 492.
† *Ibid.*, 1922, vol. 19, p. 52.
‡ *Ibid.*, 1922, vol. 19 (2), p. 553.

of an inch, or less, apart is held a thin, flexible, tightly strained steel disc. The thin and thick plates are insulated from each other and form an air condenser. If an alternating potential difference is applied to the plates the flexible plate vibrates and emits a musical sound.

If, on the other hand, the plates are kept charged by a battery through a high resistance, and if the flexible plate is caused to vibrate by sound waves, the capacity of the condenser is periodically varied and hence the potential difference at the ends of the resistance also varies. This small varying potential difference can be amplified by thermionic valves and measured on a suitable thermo-electric voltmeter.

Hence the condenser transmitter can be calibrated by operating on it with known pressure variations and then used to produce sounds having known condensations and frequencies.

The theory of the instrument has been fully discussed by E. C. Wente * in a paper on "A Condenser Transmitter as a Uniformly Sensitive Instrument for the Absolute Measurement of Sound Intensity."

In an instrument used in the research laboratories of the American Telephone and Telegraph Company, U.S.A., the diaphragm consisted of steel disc 0.007 cm. in thickness and 4.5 cm. in diameter, having a natural frequency of 17,000 p.p.s. The air-gap was 0.0022 cm. in thickness and could withstand a pressure of 320 volts direct current. The condenser capacity was 335 $\mu\mu$F. Aided by this appliance Fletcher and Wegel showed that at a frequency of 60 p.p.s. the R.M.S. value of the variable part of the air pressure corresponding to a just audible sound was 0.15 dyne per cm.^{2} At a frequency of 1,000 p.p.s. it was 0.001 dyne per cm.^{2}

There are great individual variations and those who are not usually called deaf may require a variable pressure up to more than 0.1 dyne per cm^2 at 1,000 p.p.s., whilst those who are deficient in powers of audition may require even up to 1 to 10 dynes per cm^2 to hear the sound. Fletcher and Wegel embodied the results of various observers in a curve showing the R.M.S. pressures for the least audible sound at various frequencies (see Fig. 1). The condenser transmitter also enables us to measure the energy conveyed across unit area per second by air waves of the speaking voice.

In a paper † on "The Analysis of the Energy Distribution in Speech," by L. B. Crandall and D. Mackenzie, these observers found that at a distance of 1 inch from the mouth of a speaker in ordinary conversational tone the R.M.S. value of the variable part of the pressure due to speech waves was 11.3 dynes per cm.^{2} This corresponds to an energy flow of 3.2 ergs per cm^2 per second. E. C. Wente ‡ found a similar value, viz. 10 dynes per cm at 3 cm^2 distance.

(To be continued.)

Beaufort West (**S.A.**).—At a recent meeting of ratepayers it was decided to raise a loan of £14,000 for a new electric-light scheme. The present plant cannot cope with the demand, and, further, it is being worked at a heavy loss. It is therefore proposed that it should be scrapped and a new electric-light plant erected to supply the town and also bulk current to the railway administration.

* *Physical Review*, 1917, vol. 10 (2), p. 39.
† *Ibid.*, 1922, vol. 19 (2), p. 221.
‡ *Ibid.*, 1922, vol. 19, p. 502.

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Questions and Answers by Practical Men.

RULES.

QUESTIONS : *We invite our readers to send us questions, preferably on technical problems that have arisen in actual practice. Questions which we consider of sufficient interest to our readers will either be replied to under "Answers to Correspondents" or replies will be invited from our readers. One shilling will be paid for the question which we select for competitive replies in this column.*

ANSWERS : *A fee of 10s. will be paid for the answer which we consider shows the greatest merit, and 5s. for the one we select as second best. In judging the replies, importance will be attached to clearness and conciseness, as well as accuracy. The Editor reserves the right to make no award, or to accept only one reply, if, in his opinion, the answers received do not possess sufficient merit. Competitors desiring the return of their manuscripts, if unaccepted, should enclose stamped addressed envelope.*

Write on one side of the paper only, and if diagrams are sent, draw them on a separate sheet of paper attached to the manuscript. Competitors may adopt a "nom de plume," but, both in the case of questions and answers, the competitor's real name and address must be sent with the manuscript as a guarantee of good faith. No correspondence will be entered into with regard to successful replies. The Editor's decision is final.

Commencing with Question No. 101, *a Diploma of Merit will be awarded to the six competitors who win the first or second prize the most times during the next twelve months.*

The words "Questions and Answers" or "Q" and "A" should be placed at the top left-hand corner of all letters intended for this column.

QUESTION NO. 171.

I have a 10 h.p. motor and the cone insulation on the vee rings has given out. How can I build this up again?—"A. C. WARNER."

QUESTION NO. 172.

Can any reader give working details of the method of producing power by means of motor generators for motion picture work? I require 75 amperes at 75 volts.—"CINEMA OPERATOR."

(*Replies to Questions Nos.* 171 *and* 172 *must be received not later than December* 1, 1923.)

DISPLAY MEN AT THE B.T.-H. COMPANY'S DEMONSTRATION ROOMS.

The British Association of Display Men visited the Demonstration Rooms of the Lighting Service Dept. of the British Thomson-Houston Co., 15, Savoy Street, on Thursday evening, November 22, to hear a lecture by Mr. W. Millner, B.Sc., A.M.I.E.E., illuminating engineer of the company, upon lighting effects as applied to shop windows.

In commencing his lecture, Mr. Millner welcomed the members of the British Association of Display Men, and referred to the fact that recent years had seen considerable developments in shop-window lighting. He knew nothing about display, but something about light; and, although it was easy to produce lighting equipment, it was not always easy to apply it to its best use.

Continuing, Mr. Millner expressed the opinion that shop-window lighting is probably the most important way of attracting custom to any business premises. There was not the slightest doubt that, if correctly applied, it had enormous advertising value, and was really an important factor in display. He then drew attention to a model shop window, dressed by Messrs. Lyons and Co., and specially designed to demonstrate lighting effects. He switched on what was recognised as the method adopted of lighting 50 per cent. of shop windows—a number of cord pendants and bare lamps, the glare from which was most pronounced and reduced the ability of anyone to see clearly when looking in the window—and stated that this method of lighting was a legacy from the carbon lamp era, when it was necessary, owing to the low efficiency of the lamp, to hang the latter as close to the goods as possible in order that they could be easily inspected. Such methods of lighting did not encourage one to look into a shop window. The use of lamps has not progressed at the same rate as the development of the lamp itself, and they were installed without due regard as to their suitability for the purpose they were intended to fulfil. Dangling them at eye level made it a physical impossibility to examine the contents of a window in comfort, owing to the extreme contrast between the intense brightness of the lamp filament and the comparative darkness of the goods displayed. With this system of lighting not only was a large proportion of the light sent in an upward direction, but a considerable amount was thrown outwards through the window. Such light could never, under any circumstances, efficiently illuminate the display for which it was intended.

Mr. Millner then demonstrated the use of coloured light and spotlights, and dwelt at some length upon the efficiency of colour as an attractive medium. He also carried out a demonstration in connection with reflectors fitted with colour screens, the lamps in the reflectors being manipulated by rotary dimmers. Three colours were used—red, green and blue—one dimmer being connected to each circuit and colour. Each dimmer was controlled at a different speed, thus producing a multitude of colour mixtures, the varying tints of which were of infinite variety. Afterwards he showed, by means of lantern slides, several well-illuminated shop-window displays, and indicated the results of actual tests carried out, which clearly proved that the attracting power of a shop window was considerably increased under high intensities of illumination. By increasing illumination from 15 to 100 foot-candles, 78 per cent. more people stopped to examine the window. Using the same amount of energy, but with colour effect, an increase of 18 per cent. was recorded, thus showing clearly that light has an important bearing on the selling value of a window.

He then dealt at some length with what is undoubtedly the greatest enemy of display men—the daylight reflections in shop windows. He pointed out that it was hardly possible to overcome these reflections entirely, but he knew of two methods by which it was accomplished to a certain extent. One was by fitting inclined windows in the shop front so that the dark pavement was reflected on the glass instead of the sky or a building opposite. The other was by means of floodlight projectors fitted in such a manner that a beam of light was thrown upon the chief object of the display, thus causing it to stand out and be clearly visible from the street.

A lively discussion then ensued. One member of the Display Association said he noticed in his district, where he had shops in both narrow and wide streets, that daylight reflections were more intense in the wider streets. Mr. Millner then explained that this would be so because of the direct light from the sky, and that also reflections from light-coloured buildings opposite would be sure to be prominent. The subject was receiving very serious attention, and experiments would be made until the problem was successfully solved. He then suggested that, to obtain the best results from both the display and lighting point of view, it appeared to be necessary for the illuminating engineer and the

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display man to co-operate. The display window was a stage, and the goods displayed appealed to the general public. It is the "silent salesman." During the day-time people were too busy to stop and look into shop windows, and it was only at night time that one had time to spare. It was, therefore, a paying proposition to illuminate the shop windows at night after the shop was closed, and the goods could then be inspected at one's leisure. Human beings are much like moths—that is, they are attracted by light—and an inspection at night would often lead to a purchase on the following day. It was, therefore, essential that the display should look as well as possible under artificial light, and it was here where co-operation between the display man and the illuminating engineer would be necessary. A certain quantity and colour of light for one display would not be suitable for another. If the display man would state his requirements, they would undoubtedly be met.

At the conclusion of the lecture, Mr. E. Wilson, president of the Association, thanked Mr. Millner for his most instructive lecture. He said he had seen lighting effects that night he had never seen before. He agreed that colour as an attractive medium was among the foremost, and, as a matter of fact, he intended to use it in his shop during Christmas week. He expressed the opinion that overcoming daylight reflections should receive serious consideration. As the matter stood at present daylight reflections were a drawback to the artistry of a display. He welcomed the suggestion that the display man and the illuminating engineer should co-operate, and would bring the matter up at their next committee meeting, when it would be thrashed out and all possible benefits considered.

ELECTRIC POWER IN TELEPHONE EXCHANGES.

At the meeting of the Informal Section of the I.E.E., on Monday, November 19, Mr. J. R. Bedford was in the chair, when Mr. A. B. Eason opened a discussion on "Electric Power in Telephone Exchanges." He said many engineers were unaware how much power was used and what it was used for. Batteries of 1,000 ampere-hours are quite ordinary, and an exchange now completing will have four batteries of 50 v. 1,000 amp.

Mr. Eason showed a number of lantern slides illustrating various exchanges and their details, also switchboards and connections. He compared the systems of manual and automatic selection, and described the relays which function during the process of making a call. His account of the methods adopted to counter vibration and the new universal practice in the Post Office of covering the battery acid with a thick film of oil were points that were subsequently fully debated.

Mr. F. Gill said he first met with oil to prevent accumulator spraying at Marseilles in 1919-20, and was much impressed with it. The battery makers, however, objected to it, though he believed they were now satisfied that a suitable oil was obtainable and had withdrawn their opposition. He asked for opinions on the economics of two batteries instead of one. Against the obvious disadvantages of more space and more cost you can use a commercial type generator.

Mr. F. Pooley said that the size and capacity of telephone batteries has so extended that the charging machine is now within the field of the ordinary large dynamo manufacturer.

Mr. A. F. Harmer said he had found compressed cork a success in absorbing vibration from machines.

Mr. A. G. Hilling thought the mercury arc rectifier should be more used for charging, and he pointed out that a floating battery requires extra regulation and switchgear.

Messrs. P. Dunsheath, W. Day, W. E. Rogers, W. L. Wreford and G. Wheeler also spoke.

Mr. Eason, in reply, said he did not know the origin of the oil that had caused so much discussion, but it was known to him as Oil, Insulating, No. 3.

On the point of two batteries versus one, engineers are still divided as they are on the most suitable voltage.

It was, however, essential to guard against failure of external supply, so they had to provide a 36-hour battery. All things considered, he felt two batteries had the most advantages. In regard to American practice they had one very great advantage there—practically all their machines are made by one concern, and they got very satisfactory standardisation. Mercury arc rectifiers are good, but it is with current beyond their scope and with the big generators that vibration is most troublesome.

Reviews of Books, &c.

[*Books noticed in this column will be sent from* ELECTRICITY *Office to any part of the world, for the published price, plus five per cent. for postage (minimum 2d.), and orders will be appreciated.*]

AN INTRODUCTION TO WIRELESS TELEGRAPHY AND TELEPHONY FOR THE GENERAL READER. By J. A. Fleming, M.A., D.Sc., F.R.S. (Pitman, 3s. 6d. net.)—A book from so able a writer as Dr. Fleming, who might be termed the "Grand Old Man" of wireless, will most certainly provide a very sound basis for the general reader on which to build his knowledge of wireless telegraphy and telephony. It should be sufficient to say that the ground is thoroughly covered, and most certainly up to date, and, while obviously not a book for the expert, it contains some valuable diagrams and suggestions not covered by many books on this subject. As is frequently the case, the reading of the history of past developments may open up some new spheres of research, or some ideas previously overlooked. New methods are not always the best, and a study of the historical side throws fresh light on new and recent developments. The book might be described as a plain, practical introduction to wireless generally. It is well and amply illustrated and concisely written, and, when we say it has a different atmosphere to most wireless books, we are not speaking in any derogatory way. Some of the terms, while, of course, strictly correct, and in many instances strictly scientifically correct, are not used by most authors when dealing with wireless subjects. We refer to such remarks as: "A high-resistance bell telephone receiver," "a triatic stay," "the oscillation transformer." It is, however, such phrases that give the book its writer's personality, and in strongly recommending it to all readers who are interested within

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its scope, we can only say that its value would be increased if the existing frontispiece were deleted, and one showing the author's photograph inserted in its place.

PRINCIPLES AND PRACTICE OF WIRELESS TRANSMISSION. By G. Parr. (Ernest Benn, Ltd., 5s. net.)—This book is a very simple and concise description, and very clearly covers the ground suggested by its title. The arrangement is good, and the reader is led step by step from the brief outline of the electron theory to some of the normal standard transmitting circuits.

With this book, as with others, it is a pity that authors do not adopt the standard conventional diagram signs suggested by the British Standardisation Committee. In this case the author gives a frontispiece showing certain diagramatic signs, but for some reason or other he does not use his own signs in many of the diagrams given.

The book is of little value to those having some knowledge of the subject, but is one that should be read by all who wish to have a general outline of the principles of wireless transmission, and who have little or no knowledge of the allied subjects, some understanding of which is essential before reading the average book on the transmission of wireless signals.

The book is well printed and makes good reading. There are, however, quite a number of small errors in the printing of the text. The Polar "Pea-nut" valve is referred to, and the voltage is given as .08 to 1, which should, of course, be 0.8 to 1.

In the diagram showing the Poulsen arc transmitter it is not quite clear that the two blow-out or magnet coils are in series with the arc. The left-hand coil is clear, but the right-hand coil appears to be shorted by the lead to the closed circuit inductance. This is probably due to a defect in the block. In speaking of the same diagram, the question of the marking and spacing wave is simply described, and what is in all probability a printing error has crept in here, as when the total inductance is reduced by depressing the transmitting key, the wave-length is momentarily decreased and *not* increased.

To wireless amateurs who are thinking of building a transmitter the last chapter, although short, will give them a clear insight into modulation methods, and if their knowledge of the subject is not great, then a careful study of the book will give them a thorough groundwork in general principles.

"**Sixty Years of Company Registration.**"—A lecture on this subject, by Mr. Herbert W. Jordan, the well-known authority on company registration, was given recently before the Secretaries' Assocn., Ltd., at the Cannon Street Hotel, under the chairmanship of Mr. T. E. Haydon, M.A., K.C., and was of such an interesting and informative character, and the proposed amendments of the Companies Acts are so worthy of consideration, that, by desire, it has been printed. It could be read with advantage by every company secretary.

Meetings.—The Junior Inst. of Engineers will meet on Friday, the 30th inst., at 39, Victoria St. Lecturette, "Notes on Design of Paraffin Motors," by Stratford C. Saunders (member) (slides and exhibits). On Friday, December 7, there will be a visit to the Lighting Service Dept. of the British Thomson-Houston Co., 15, Savoy St., at 7.30 p.m., with a lecture and demonstration on modern methods of electrical illumination. On Friday, December 14, meeting at 39, Victoria St. Lecturette, "L.C.C. Regulations for Steel-framed Buildings," by S. Bylander (past-chairman) (slides). All at 7.30 p.m.

Trade Notes.

The bullet in Benji did not cause a fatal wound, but it should most certainly inflict very serious injury on the demon of bad lighting, and for that we can but express our most grateful thanks to the editor of the "Benjamin Bulletin" for November, who shows so clearly what can be done with the aid of the good lighting fairy. This number deals entirely with lighting, and contains some excellent illustrations of really efficient illumination work in such varied directions as a power-house, a machine shop, a printing works, a motor-car works and a clothing factory, together with most interesting examples of the moderate outlay necessary to ensure correct industrial lighting. The whole issue is most certainly well worth the careful perusal of all electrical engineers who are interested in such problems, and the publishers, **The Benjamin Electric, Ltd.**, Tariff Road, London, N.17, will be pleased to send copies to any readers who may write for same.

The Exide Girl Calendar, which has just been issued by the **Chloride Electrical Storage Co., Ltd.**, is a very bold and attractive advertisement of the Exide batteries, and the charming features of the fair damsel should certainly prove an excellent daily reminder of the famous Exide cells during the twelve months commencing with this present November. It will be appreciated by all trading firms and users who are so fortunate as to receive a copy.

"**Spot-o-Lites.**"—This is the trade title given to an ingenious adaptation of the old-fashioned drawing pin. In the centre of the front is a neat white enamel circular spot of luminous paint which, when the pin is pressed into the woodwork above any ordinary house switch, will enable its position to be seen in the dark without trouble, thus avoiding accidents which inadvertently might occur when groping blindly where one might imagine the switch would be found in the ordinary way. It is a neat contraption which should find a ready market among electrical factors, ironmongers and dealers generally, and we would recommend them to apply for prices, etc., to the makers, the **Hendon Electrical Co., Ltd.**, at 104, Southampton Row, London, W.C.2, who are also handling the well-known Hendon British-made incandescent lamps.

The November monthly price list has been issued by the **Siemens and English Lamp Co., Ltd.**, of 38-39, Upper Thames Street, London, E.C.4, and will prove of value to all trade readers, to whom it will willingly be sent on receipt of proper official application.

The November issue of the "**Sunco**" monthly stock price list gives details of good selling lines in domestic electrical appliances for the Christmas trade, as well as of the Crypto commutating rectifier for economically charging accumulators and other accessories. Enterprising contractors and retailers who may not have received the list should at once write officially to the company at 118, Charing Cross Road, London, W.C.2, and ask for it, mentioning this reference thereto.

Catalogue No. 108, "Abridged Price List of Electric Lighting Material," just issued by **Croggon and Co., Ltd.** (16 and 230, Upper Thames Street, E.C.4), is a very full and convenient publication, which electrical contractors will find most useful. Attention might be particularly directed to handy tables of cables, flexibles and fuse wires, which are one of the features.

A portable electric riveter, called the "Remca," is illustrated in a leaflet to hand from the **Mada Engineering Co., Ltd.**, of 12, Bevington Hill, Liverpool. Two hundred $\frac{3}{4}$-in. rivets are dealt with in this machine for the consumption of 1 kw.-hour, D.C.

A price sheet illustrating the Tangent low-frequency transformers has just been issued by **Messrs. Gent and Co., Ltd.**, of Faraday Works, Leicester. From the nature of the testimonials the firm have every reason to be satisfied with the quality of goods which they are supplying to their clients. Evidently these transformers should form a quick selling line for all dealers in high-quality wireless goods.

A new folder just issued by the **British Thomson-Houston Co., Ltd.**, of 77, Upper Thames Street, E.C.4, gives prices and details of Mazda lamp bulbs for motor-cars, which are, we understand, meeting with a very rapid sale throughout the country.

Circulars dealing with lanterns for gasfilled lamps, Apex iron-clad switchgear and other accessories have been issued by the **Foster Engineering Co., Ltd.**, of Morden Works, Wimbledon, S.W.19, and will be sent to trade readers on receipt of proper application.

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Siemens and English Electric Lamp Co., Ltd., have opened a branch office and store at 2, Wood Street, Cardiff, where they will carry a large and comprehensive stock of lamps, accessories, fittings, cables, batteries, etc., which should afford prompt and efficient service to their many customers in the South Wales area.

The **G.E.C.** have issued a new edition of their catalogue of "Geekoduct" conduit and conduit fittings (section "C" of complete catalogue 16th edn.). In addition to the usual light-gauge and heavy-gauge conduit, and various standard fittings, complete ranges of switch and ceiling rose boxes, wall plug boxes, and other outlets are given, together with earthing devices, connectors and a selection of various tools. Included are the "Pin-Grip," "Demon-Grip" and "Witton-Grip" systems of continuity fittings. In addition, the introductory section (specification, etc.), which is illustrated by line blocks and augmented by statistical data, is useful.

"Dr. Brighton Takes a Hand in the Housing Problem" is the title of leaflet No. 409 which has just been issued by **E.D.A.** It gives neat illustrations and text descriptive of the inexpensive but wonderfully convenient and economic houses which are now being erected in Brighton, and shows what is being done in the way of utilising electricity to the best possible advantage. These leaflets should be of direct interest to all enterprising electrical contractors, as well as to architects generally, and it is to be hoped that they will be made use of to the utmost possible extent. Supplies and details can be obtained by writing to the Secretary of E.D.A., at 15, Savoy Street, London, W.C.2.

Pamphlet No. P1323 has been issued by the **Engineering and Lighting Equipment Co., Ltd.**, of Sphere Works, St. Albans. It gives particulars and illustrations of some of the latest types of industrial fittings which this company is now placing on the market at competitive prices, and should, therefore, be of direct interest to installation contractors generally, who should make early application for same.

Heating and cooking catalogue No. 6 has just recently been issued by the **Automatic Telephone Mfg. Co., Ltd.**, Milton Road, Edge Lane, Liverpool, and should be obtained without delay by all electrical traders and contractors, to whom it will be sent on receipt of proper application. It contains full details of the many new Xcel lines which the company has placed on the market, including electric irons for tourists and billiard tables, utility cookers, boiling plates and fires of various types, in all of which there should be an ever-growing market for the enterprising trader.

The **General Electric Co., Ltd.**, have issued an attractive folder, No. B.C. 3,185, dealing with Gecophone loud-speakers and showing several models thereof, as well as complete equipment, including power amplifiers. Prominent among them is a new model known as the Gecophone "A" loud-speaker, which admirably fills the demand for a thoroughly reliable instrument at a reasonable price. It is of the electro-magneto type, and the receiver is wound in such a manner that a choice of two resistances is available according to the type of valve used. Wireless dealers should make a point of obtaining copies of this new list.

United Water Softeners, Ltd., of Imperial House, Kingsway, London, W.C.2, have formed a separate company, under the title of **Super-Centrifugal Engineers, Ltd.**, to deal exclusively with the ever-growing business of the Sharples super-centrifuge, a machine which enables enormous centrifugal force to be applied in the clarification and separation of liquids and emulsions produced in over a hundred different industries. The board also has been strengthened by the inclusion of Mr. P. T. Sharples, the president of the Sharples Company of America, and of Messrs. A. H. Keable and Z. A. Toula, technical directors.

Domestic, industrial and commercial lighting fittings of scientific design and careful manufacture are offered this season, as in the past, by **Simplex Conduits, Ltd.** (Garrison Lane, Birmingham). The wide range available is catalogued in a series of octavo booklets with substantial covers, and merits consideration by illuminating engineers and contractors. An important section of the company's business is devoted to the design and manufacture of artistic signs, some examples, specifications and prices being given in a new booklet, "Simplex Triple-purpose Electric Signs" for advertising, illuminating and decorating.



Various Items.

Inquiry Postponed.—The Electricity Commissioners have decided to postpone the local inquiry at Bradford into the West Riding (Aire and Calder) Electricity District, which was fixed for December 4 and following days. A new date will be announced in due course.

Burnley.—The Electricity Committee have decided to extend the electricity cable for about 1,000 yards in Barden Lane if there are sufficient inquiries for supplies in this area. The laying of cable in Rosegrove and Lowerhouse districts is regarded as suitable to earn the unemployment grant from the Government.

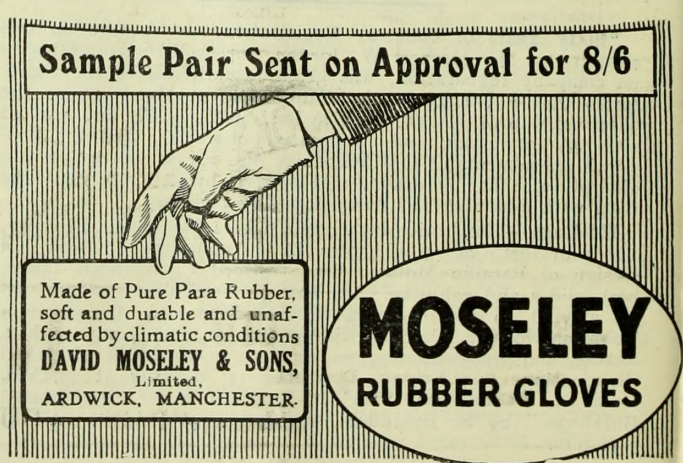
British Empire Producers' Organisation.—We are informed by this organisation that the Right Hon. S. M. Bruce, the Prime Minister of the Commonwealth of Australia, has accepted the office of patron. The Right Hon. the Earl of Glasgow, D.S.O., R.N., has been elected president, and the Right Hon. L. S. Amery, First Lord of the Admiralty, a vice-president.

Plant Wanted.—The Victorian Rlys. invite tenders for the supply of two small induction motors, complete with starting apparatus.——The Sydney (N.S.W.) Harbour Trust Commrs. invite tenders for the supply and delivery at No. 6 Berth, Darling Harbour, Sydney, of two double-drum horizontal electric capstans or warping winches (Contract No. 23/34). Particulars from the D.O.T. (Room 50), 35, Old Queen Street, London, S.W.1.

Thame.—At a town's meeting, held on the 15th inst., to discuss proposals in connection with the provision of an electricity supply, a lecture was given by Mr. Victor W. Dale (business manager of the E.D.A.) on "The Uses of Electricity in Home and Business," following which a resolution was unanimously passed recommending the Council to investigate the best means of obtaining a supply as early as possible, one lady in the audience stating that she was willing to put in 100 points at once.

Tenders Accepted.—The Sloan Electrical Co., Ltd., of 8, 10 and 12, Golden Lane, London, E.C., as agents for Messrs. Peyton and Peyton, Ltd., of Birmingham, have secured the contract for the supply of the whole of the electric decorative fittings for the "Rivoli" Cinema, which is being built in Capel Road, Worthing, by Mr. C. A. Seebold, proprietor of the "Dome" Cinema, Worthing.——The following contracts for Osram lamps have recently been obtained by the G.E.C., viz.: (1) L.M. and S.R., for Osram gasfilled lamps for three months ending December 31, 1923; (2) Southern Railway, for Osram incandescent lamps for four months ending February 29, 1924; and (3) H.M.O.W., Osram metal filament, vacuum and gasfilled lamps during the period of nine months from October 22, 1923.

Meetings.—A Wireless Section meeting of the I.E.E. will be held on Wednesday, December 5, at 6 p.m. Paper: "The Relation between Damping and Speed in Wireless Reception," by L. B. Turner, M.A.



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V.I.R. CABLES—THEIR MANUFACTURE AND SELECTION.*

The meeting of the Association at St. Bride's Institute, London, on November 13, was well attended, the room being well filled when Mr. W. Lang, M.I.E.E., delivered his lecture on " V.I.R. Cables : Their Manufacture and Selection." The President of the Association, Mr. W. E. Highfield, M.I.E.E., took the chair promptly at 7 p.m., and in opening the meeting, referred to the important part cables played in the cost of installations. Before calling on Mr. Lang to speak, Mr. Highfield extented a cordial welcome to the visitors who were present, and invited them to join in the discussion.

Mr. Lang, who read his paper in a most clear and enjoyable manner, said :—

INTRODUCTION.

The history of the electric cable industry, particularly that section of it with which we deal in this paper, might be likened to that of a country favoured by wise government, enjoying freedom from strife and devoted to the pursuit of the prosperity and well-being of its people.

This is somewhat exceptional in the history of the electrical industry taken as a whole, as the growth of demand for current has been so great that designs and forecasts of plant of thirty years ago appear grotesque when compared with the giants of generation of to-day.

At the same time the almost peaceful progress of the electric cable industry has been definite and decisive, although it is difficult to mark any particular date as the birth of some great advance in this manufacture. The amount of research and experimental work devoted to details of manufacture has resulted in many erroneous ideas surrounding the art being eliminated, and the user assured that he can obtain a commodity that has been well and truly made.

* Lecture delivered by William Lang, M.I.E.E., before the National Assoc. of Supervising Electricians, November 13, 1923.

It is safe to say, however, that some mystery will always be associated with electric cable making—just as there always will be mystery in a somewhat kindred art, that of cooking—and, as in cooking, so in the making of V.I.R. cables, there will always be " masters " of the art whose skill is beyond question.

In many ways this is readily appreciated, at least by those who have entered light-heartedly into the business and have come to grief in its many pitfalls, and yet there are many users who wonder where the difficulties are, as apparently the manufacture is quite straightforward. This is particularly true of the " book " expert, as although a fair amount of literature is available on the subject, yet it is " scrappy," that is, you get a bit here, and a bit there, and with it all there is probably more left unsaid about these mysteries than has actually been written. Nevertheless, it is possible to acquire a good knowledge of the art which has always been looked upon with a certain amount of respect as having its own special and peculiar difficulties.

In any case, with such sources of information available, there seems to be little need for a user to worry over the selection of the cable he proposes to purchase.

Actually, however, he finds that there are so many factors which require consideration, that, in balancing them one against the other, he is continually confronted with the difficulty of a decision.

In order to grasp the essential points which should be looked for, I propose to run over, briefly, what the salient points are in V.I.R. cable manufacture.

Principal Features in Manufacture.—The manufacture divides itself almost naturally into three main divisions. That pertaining to :—

(*a*) The conductor.
(*b*) The insulating coatings.
(*c*) The finish or protection of the insulating coatings.

Of these the work entailed in connection with the insulating coatings easily takes the premier place of importance, but the finished cable will only be satisfactory when careful attention has been given to every operation—not one stage can be treated lightly.

The most important operation on the conductor is that of tinning. All specifications and all rules and regulations dealing with V.I.R. cables embody a clause insisting upon this.

The existing rules of the Institution of Electrical Engineers refer to " tinning " under Rules 41 and 56, but simply state that " the copper must be protected by tinning or other effective method from contact with the insulating material if such contain sulphur."

Not infrequently specifications are more precise on this point by adding such words as " the tinning should be free from lead or other impurity and should show no signs of sulphate of copper after vulcanisation."

One specification called for " double tinning," but this is rather a refinement, as the resulting benefit is doubtful—little, if anything, can be expected from trying to tin copper unless the surface is absolutely clean, as all of us have learned from experience, so that any attempt to improve matters by a second operation is futile.

Tests for tinning are not common, but where this is called for, a satisfactory test is that known as the " Beaver " test, in which the tinned wire is subjected to the action of solutions of hydrochloric acid and of

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sodium-sulphate alternately in cycles for a predetermined period.

Taking a broad view of this operation, and bearing in mind that every inch of the wire must pass through the tinning bath, making it at best a relatively slow process, it can easily be seen that any attempt to speed up the running will only result in bad workmanship at this the very outset of the manufacture.

The conductor itself must be of annealed copper, and this is so usual and the reason so obvious that it might pass without reference. I only do so to draw your attention to the outstanding difference between annealed copper wire and that of hard drawn copper wire. This may best be done, I think, in the terms of the Standards of the E.S.C. in which is taken, in each case, a length of wire of one metre, each weighing one gramme at the temperature of 60 deg. F., when annealed copper is defined as having R = .1508 ohm. and H.D. as having R = .1539 ohm. In addition the E.S.C. define H.D. copper as that which will not elongate more than 1 per cent. without fracture.

In passing, also, I should like to remind you that as H.D. copper softens very readily when heated, it is looked upon as bad practice to make a joint, on bare H.D. copper overhead wires, in any part of a span or to take a branch from off any part of a span when soldering is done.

It is interesting also to note that you can readily obtain the weight in lbs. per yard of any conductor by multiplying the cross sectional area by the constant 11.575; or roughly, a wire 1 sq. in. in section area weighs 11½ lb.

One further operation requiring care is that known as "stranding the conductor." In this process each wire is separately wound on a bobbin and the requisite number of bobbins are mounted, in quite a simple but ingenious way, on the periphery of a wheel. From these bobbins the wires converge through a guide or multiple die to the central wire of the strand which has been threaded through the hollow shaft of the machine. As the wires are pulled forward, with the revolving of the shaft, so a rope or strand is formed. During the operation the bobbins of wire on the periphery of the wheel oscillate in such a manner that no twist, or, as sailors put it, "turn," is put on the wires as they bed themselves down on the central wire. The care required in this operation is to see that no scratching of the tinning takes place, a condition not always easy to fulfil.

The numbers of wires in circular strands are quite well known to you, being 7, 19, 37, 61, 91 and 127, as where three wires are twisted together a strand, in the proper sense of the term, is not formed. The numbers of wires, in circular strands, form a series of the equation $3n(n + 1) + 1$ where n is any integral number representing the number of layers.

The single conductor wire, or the stranded conductor, is now ready for what is a more important operation—that of receiving the insulating coatings.

The standard practice in this country is to apply three distinct layers of insulating rubber—one of rubber strip and two of vulcanising rubber applied in the order of :—

(*a*) The rubber strip next to the conductor.
(*b*) The first layer of vulcanising rubber, termed the "separator."
(*c*) The second layer of vulcanising rubber, termed the "jacket."

As the positions and names indicate, each layer has its own function to perform, and each is, of course, separately prepared and manufactured.

In the application of these layers to the conductor there are two methods in common use, one known as the "Longitudinal" method and the other as the "Lapping" method.

In the "Longitudinal" method the three strips of rubber, in the order already named, are fed, at one and the same time, to the top and to the bottom of the conductor as it passes through two rollers, having die grooves of the requisite finished diameter of the particular size of insulated wire which is being dealt with. These rollers press together the three strips on the top to the three below the conductor, and, at the same time, nearly cut them through on each side, so that the wire issues from the roller quite circular in form, but having the faintest indication of a web on each side where the cutting through took place.

In the "Lapping" method the three lappings of rubber, in the same order as before, are applied by revolving the strips, with a predetermined "lay," on to the conductor as it is drawn through the machine.

Of these two methods the "Longitudinal" is in most general use, except for cables of a considerable diameter, as it is possible to pass several conductors at one time, side by side, through the rollers by providing strips of rubber of sufficient width to "insulate" all the wires at the one operation.

With the "Lapping" method, however, only one wire at a time can be dealt with and, consequently, the "mileage" of wire insulated in a given period is greatly reduced.

Following upon the completion of this operation, the drums, which received the wires as they issued from the insulating machine, are taken to the taping machines, where the "proofed" tape is applied, and thereafter the cable is ready for the vulcanising shop.

Vulcanisation.—I approach this part of the subject with some trepidation for three reasons :—

(*a*) That it is highly technical.
(*b*) That it is hedged round with trade secrets.
(*c*) That apparently there is no standard practice—manufacturers securing the results for which they strive in more or less independent ways.

It is perhaps the most vital operation of all in the whole process of V.I.R. cable manufacture, and it is significant that all specifications leave this entirely in the hands of the manufacturer.

This, to my mind, is rightly so, as it is always accepted that, in drawing up a specification, you can do one of two things :—

(*a*) You can give working dimensions and tests of the finished article, leaving details of manufacture entirely to the manufacturer; or (*b*) you can stipulate the exact method of manufacture and, in so doing, take upon yourself the responsibility of the result, as in such a case, naturally, the test of the finished cable—in cable making—would depend upon the method of manufacture you had laid down.

The soundness of leaving the method of manufacture in the hands of the manufacturer has resulted in a great amount of research and experimental work being done voluntarily, and it appears as though the

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making of one good cable is only an incentive for further efforts in improved manufacture. Indeed, when we come to consider the views and opinions of "masters" in the art of vulcanisation we see how very involved the whole subject is, and what measure the responsibility is in turning out a sound cable.

(To be continued.)

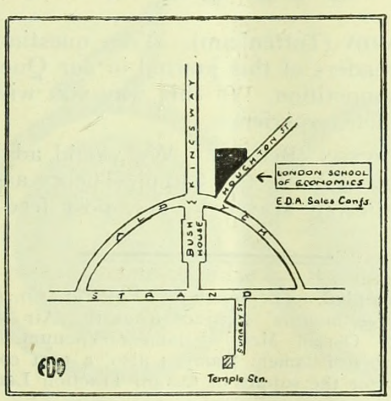
POWER SIGNALLING INSTALLATION AT NEWPORT STATION, G.W.R.

An extensive power signalling scheme is to be installed at the Newport Station of the G.W.R., the contract having been awarded to Messrs. Siemens Brothers and Co., Ltd., London, for the supply and installation of their one-lever system of route signalling. The contract includes the supply of generating plant and storage batteries at east and west cabins, the necessary electrical apparatus for working 200 signals and 100 points, and the station limit track circuits with illuminated diagrams at each cabin. This will be the first large installation of this new and advanced signalling system, its efficiency having been fully proved by a small trial plant which was installed at Winchester twelve months ago for the same company. The outside gear, such as point and signal machines, is of a type which Messrs. Siemens have supplied and installed for some time. The great advantages accruing from the operation of a whole route by a single lever are obtained by local circuits in the relay control case of the cabin.

E.D.A. SALESMANISHIP CONFERENCES.

Owing to the large numbers attending the E.D.A. Sales Conferences this year, the Association has found it necessary to obtain a larger hall.

The next meeting (December 14, 7.30 p.m.) and all subsequent Conferences will be held at the London School of Economics, Houghton Street, Aldwych, on the ground floor. The main entrance to the London School of Economics is almost immediately opposite Bush House, as shown in the street plan hereunder.



The new hall will permit of still larger attendances, and the Association desires to emphasise the fact that the Conferences are open to anyone engaged in any branch of the electrical industry, supply, contracting or manufacturing, and particularly to the younger men at the selling end of the business. There is no fee.

THE ENGINEERS' CLUB.

The following is a list of the meetings to be held in the club during December, 1923 :—

Dec. 10.—London Section of the Institute of Brewing.
,, 11.—Mining and Electrical Engineers.
,, 12.—Institute of Motor Trades.
,, 13.—Institute of Patentees.
,, 14.—Institution of Aeronautical Engineers.
,, 17.—Institution of Rubber Industry.
,, 19.—Institution of Production Engineers.
,, 20.—Institution of Mining and Metallurgy, Council Club Dinner.

THE "LUXOR" UNIT SYSTEM OF DECORATIVE LIGHTING.

With the object of eliminating glare in domestic lighting by gas-filled lamps, the British Thomson-Houston Co., Ltd., have placed on the market a decoratively adaptable fitting called the "Luxor." By means of a vitreous enamelled reflector, to which a diffusing bowl is attached (see Fig. 1), about 75 per

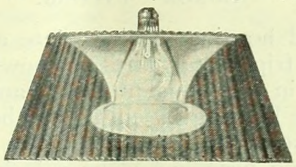


FIG. 1.—PHANTOM VIEW OF "LUXOR" FITTING, SHOWING SILK SHADE.

cent. of the light is reflected upwards to the ceiling (from the inner surface of the reflector), and about 25 per cent. is diffused through the bowl. A small proportion of this diffused light reaches the outer surface of the reflector and illuminates the silk shade, should one be used. Thus, it will be seen, the main lighting is well diffused throughout the room, no harsh contrasts obtaining. At the same time just sufficient light is available for illuminating the shade to the necessary degree for securing artistic effect. Shades

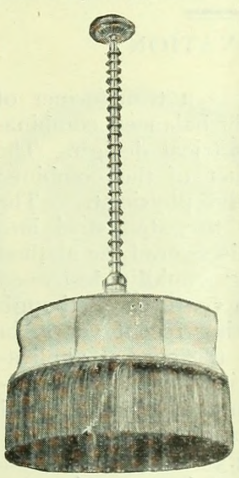


FIG. 2.—A REPRESENTATIVE "LUXOR" FITTING.

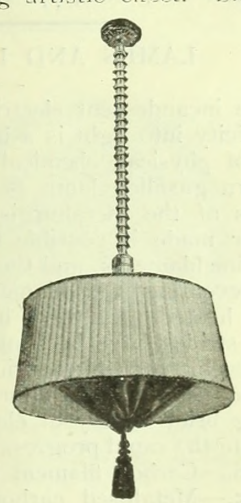


FIG. 3.—A TYPICAL "LUXOR" FITTING.

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can be obtained in practically any colour—a representative example of a "Luxor" fitting being shown in Fig. 2, while in Fig. 3 is seen a silk bag or screen fitted over the diffusing bowl. These screens are primarily intended for use when the bowl is in the line of direct vision. Spare plain opal or cut-glass diffusing bowls may be obtained. Easy assembly is a feature of these fittings, as shown at Fig. 4. The three essential parts are (*a*)

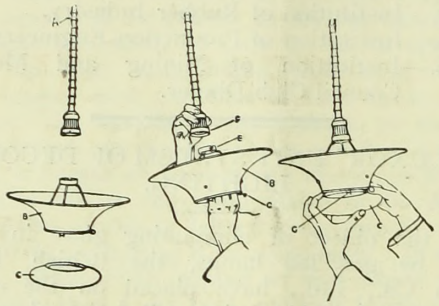


FIG. 4.—DIAGRAMS SHOWING METHOD OF ASSEMBLING "LUXOR" FITTING.

suspension and housing, ceiling plate and wiring, (*b*) reflector with tripod, (*c*) diffusing bowl. The ceiling plate is fixed in the usual manner, and the reflector attached to the housing by engaging the bayonet slots in the top of the tripod (*e*) with the pins in the housing (*f*). This having been locked by a locking screw, the lamp may be inserted, and the diffusing bowl attached to the reflector by the three spring fingers (*g*) at the bottom being made to engage the edge of the bowl.

The length of the suspension is easily effected by adding or removing a number of thimbles, and, of course, lengthening or shortening the cable. Cleaning or lamp renewal is carried out by removing the diffusing bowl, which, as stated above, is held in position by springs.

For offices, shops, showrooms, restaurants, etc., the "Luxor" fitting can be used effectively without a silk shade, this being used only for decorative effect. Full particulars are contained in a booklet which will be gladly sent to those applying to the British Thomson-Houston Co., Ltd., 77, Upper Thames Street, E.C.4.

LAMPS AND ILLUMINATION.*

The incandescent electric lamp as a transformer of electricity into light is a beautifully balanced combination of physical, chemical and electrical design. The modern gasfilled lamp is a product of the combined efforts of the metallurgist and the physicist. The former made it possible to draw tungsten steel into very fine filaments, and the latter discovered the method of preventing the filament being rapidly destroyed when heated to a very high temperature. Although rapid strides have been made, during recent years, in the development of electric lamps, the correct application in use has not appreciably improved. The following brief history of electric lamp development will indicate the rapid progress which has been made:—

1896.—Carbon filament lamp—3.3 lumens per watt.
1905.—Metallised carbon filament lamp—4 lumens per watt.
1906.—Tantalum filament lamp—5 lumens per watt.
1907.—Pressed tungsten filament lamp—8 lumens per watt.
1911.—Drawn tungsten filament lamp—10 lumens per watt.
1913.—Gasfilled lamp—20 lumens per watt.

It will be seen that the increase in efficiency from the carbon lamp to the gasfilled lamp is 600 per cent. During this period of progress the cost of current has been steadily reduced so that, for the same cost, the consumer can now enjoy about ten times the amount of light that was possible 23 years ago. These figures, however, merely refer to the light sources, and do not take into account the many advantages to be obtained by correct distribution.

In spite of rapid progress in lamp development, and the improvement in the design of lighting equipment, the public remains strangely ignorant of the advantages of good lighting. The general practice has been, as new lamps are produced, to instal them in the old equipment. The time has now arrived when the industry must make a serious effort to correct this evil practice. There are in use to-day hundreds of glaring lamps which are causing great discomfort, and, in many cases actual injury, to the eyesight of the general public. It would be quite impossible to introduce still more efficient lamps until the public have been educated to adopt better lighting practice.

Generally speaking, light is still considered merely as a convenience. The public have yet to learn that it is probably the greatest asset available to mankind; this is particularly true of industrial lighting. Many careful and conclusive investigations have been made which prove that production can be considerably increased when antiquated lighting systems, giving a poor illumination, are replaced with correctly installed equipment, giving a high intensity of illumination. In his recent paper before the British Association, Dr. G. H. Miles gave an example of a test carried out in a factory which indicated that production was increased by 28 per cent. after a modern lighting system was installed in the factory.

* The *Benjamin Bulletin*.

Answers to Correspondents.

C. R. HARDY (Tottenham).—Your question is placed before the readers of this journal in our Questions and Answers Competition. In this way you will have the benefit of their experience.

W. J. SIMPSON (Belfast).—We would advise you to obtain a copy of "Electric Circuit Theory and Calculations," by Perren Maycock, 11s. post free from this office.

Tenders Accepted.—The General Electric Co., Ltd., has obtained a three months' contract from the Air Ministry for the supply of Osram Metal Filament Vacuum Lamps and Robertson Carbon Filament Lamps; also, a part contract from the Admiralty for the supply of Osram Traction Lamps.

Hackney.—We have received from the E.D.A. pamphlet No. 411, which relates to the public service of electricity in the Metropolitan borough of Hackney, and gives illustrations and charges which are in force in that very enterprising borough. The illustrations show the various types of electric cookers and accessories, together with the hire terms, and are a splendid testimonial to the enterprise of Mr. L. L. Robinson, M.I.E.E., the manager and engineer, to whom all credit is due.

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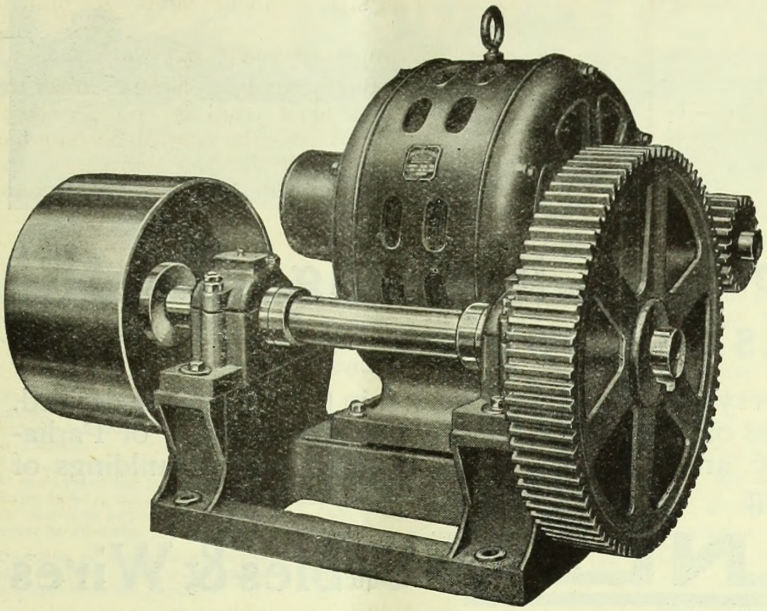
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Il ustration shows a 40 B.H.P. Standard Back-gear Motor.

NOTE the Robust design maintained throughout.

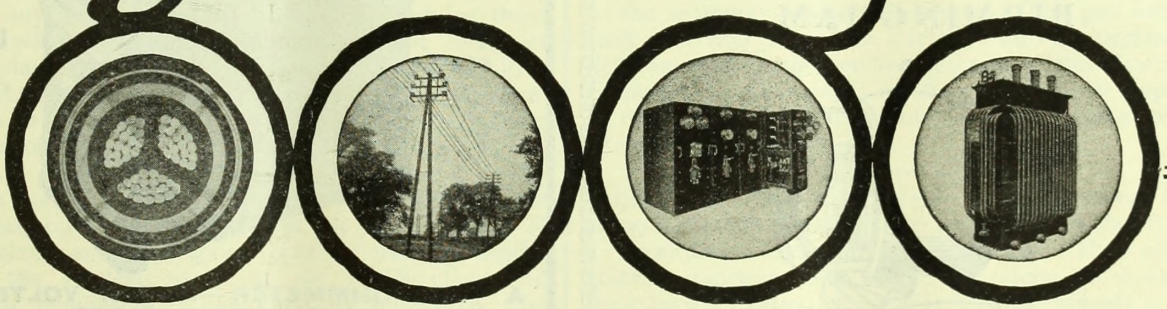
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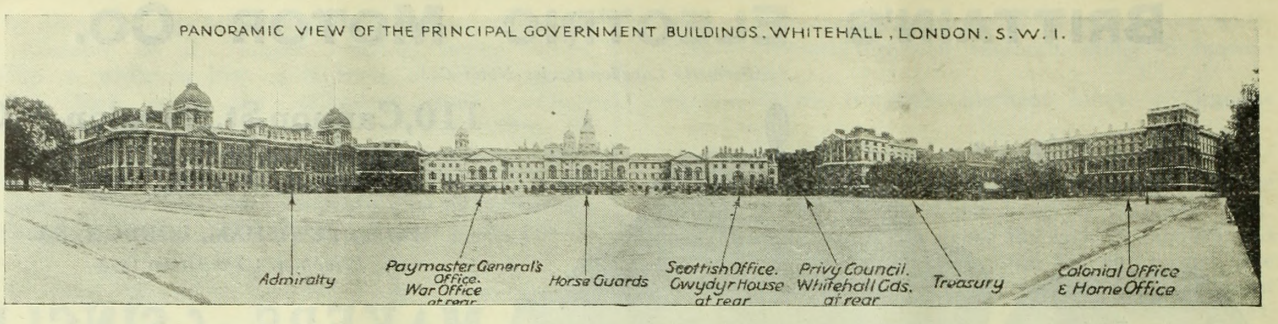


Of course we really want your orders, but we don't advertise for them. When we have induced you to send us your enquiry, the task of our advertising department is accomplished. We then have the opportunity of putting our case before you in the form of a tender supported by explanatory literature, illustrations, drawings and examples. We rely on being able to satisfy you as to price, quality, design and delivery. If it seems desirable to discuss our proposals on the spot, one of our engineer representatives is ready to wait upon you for this purpose. Should you, after all, decide to place your order elsewhere, we shall make one request only in accepting your decision, *i.e.*, that you continue to send us your enquiries, and allow us to try again.

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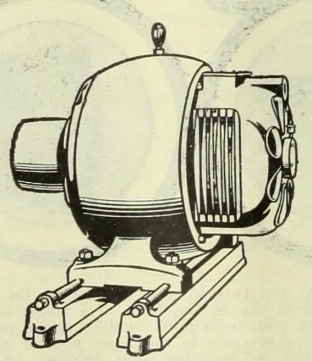
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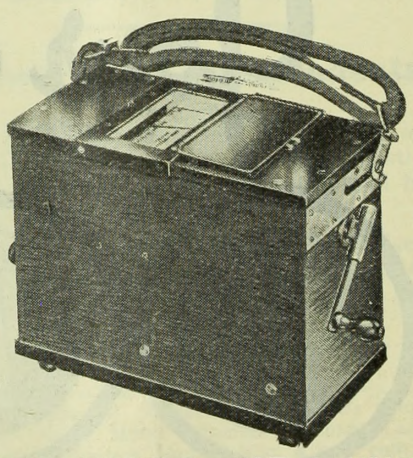
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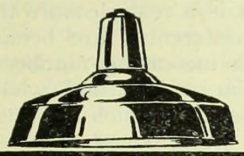
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New advertisements for the displayed columns and alterations to existing ones must reach the publishing office not later than first post Tuesday morning, in order to be in time for the issue of the following Friday. This is important. Rate quoted on application. Subscription : 13s. a year, 6s. 6d. half-year, 3s. 3d. a quarter in advance, postage prepaid in the United Kingdom and abroad.

Questions to which an answer is required must be accompanied by a 1½d. stamp for reply. When considered of sufficient interest, the answer will probably appear in the paper.

All remittances payable to the Publishers, S. RENTELL AND CO., LTD., 36-39, Maiden Lane, London W.C. 2. Telephone No. 2460 Gerrard.

Current Topics.

The Rapacious Landlord.

If there is one thing more than another calculated to sway electors at the present juncture in favour of any party which is antagonistic to landlords and property-owners, it is the recent reported action of certain landlords and house-owners in the Moston district of Manchester, where, it is alleged, several tenants have received notice of varying increases in their rent on account of the erection of outside aerials for broadcast reception. There is a class of property-owner who sticks at nothing in his endeavour to extort additional profit from his unfortunate tenants on the slightest provocation, and the growing popularity of broadcasting has opened up a fresh vista for the exploitation of the meeker class of occupier who takes that sort of thing lying down. There is no foundation in law which supports a landlord in any such action, and I strongly advise those tenants who have received notice of rent increases on this lame excuse to join the local Tenants' Protection League, or its equivalent, and try what combination will do for them against the extortionate demands of these leeches.

There was never a new pastime or recreation yet introduced but there followed in its train a class of bloodsuckers and spoil-sports bent on making capital out of the modest needs of the middle-class and industrial population. The class of individual who will extort extra rent for an aerial reasonably and carefully erected on his property is on a par with the war profiteer—that highly objectionable section of the populace which battened on the privations and discomforts willingly suffered by others of his fellow men and waxed disgustingly rich on the proceeds of his rapacity. It is up to the various wireless societies to take up this matter also and add their united protest to any such attempt to handicap a pastime which is already giving so much recreation and enjoyment to thousands of suburban and country residents in our midst. What about a test case, anyway? It would serve to expose the profiteer and also settle the question once and for all

Those Breakdowns.

Day after day we read of still more electricity supply failures, and, in addition to the list of affected areas given in my last week's notes, there have been two successive breakdowns, on two following days, in the district served by the Kensington and Knightsbridge Electric Lighting Company, one at Whitby, another at Reigate, affecting the business area, and finally at Wimbledon, this being also the second failure within a comparatively short period. In each case the local Press have made capital out of the occurrences, and are asking the very natural question, what the respective supply authorities are going to do to guard against a repetition of the danger and inconvenience, to say nothing of the financial loss, incidental to these all too frequent failures of electricity supply. Disconcerting as they are, and unforeseen as many appear to have been, the supply industry should at least take the lesson to heart and profit by its misfortunes. It would appear that an influential committee is desirable, with power to inquire into the causes of these repeated failures, and compile therefrom valuable statistics as to the several points of weakness in the respective systems, with a view to early remedial measures. The reputation of our industry is at stake, and the sooner we wake up to the fact and set about putting our house in order the better for everybody concerned.

—And Gas.

In this connection, one seldom or never hears of an absolute failure in the public gas supply, unless it is associated with some extraneous disaster, such as a street subsidence or a broken main, as, for example, in the case of the City and South London Tube works the other day. That, however, is no fault of the gas company, and, moreover, it is a case which is given such explanatory publicity that the general public are able to realise at first glance how innocent are their gas suppliers of any negligence contributing to the temporary failure of supply. The gas interests look after that side of the question, and the explanatory diagram and comprehensive account of the Newington Causeway *contretemps* which subsequently appeared in the *Daily Mail* is a tribute to those responsible for effective propaganda.

Electricity supply interests, on the other hand, always seem to emulate the ostrich when faced with a breakdown and its consequences. The affected station engineers ask to be left alone to work out their own salvation, and it is usually nobody's business to inform the public, through the medium of the Press, what caused the mishap or how long they are likely to be called upon to suffer inconvenience arising therefrom. These sins of omission count in the long run, and, taken in conjunction with the very effective propaganda now in progress to still further popularise gas for domestic uses, are calculated to do

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considerable harm to the electrical industry in so far as domestic applications are concerned. Incidentally, gas interests are making a very large and effective display at the forthcoming British Empire Exhibition at Wembley next year. The various sections of the industry have combined, and have taken a space of 12,500 feet in the Palace of Industry. Here the story of coal and gas and their possibilities will be told with the object lessons that will be a surprise and delight to the uninitiated.

The principle underlying the arrangements is to show the application of coal gas and its by-products to domestic and industrial life. A visit to the gas exhibit will give a striking illustration of the enormous range of the activities of the gas industry, and of the adaptability of gas for use in all sorts of unexpected processes. Gas in the motor industry, in sweet factories, in generating electrical energy, in the heat treatment of metals, in fruit and vegetable canning—to mention only a few of the many applications which will be demonstrated at Wembley. And what of electricity? No doubt the leading firms in the industry will make a brave display of the much more manifold uses and advantages of electricity, but are the leading interests combining with a view to countering this powerful united effort by their friendly rivals? If so, I have not heard of any arrangements in progress up to the time of writing, and time presses. Only a little short of four months are left in which to organise such a representative display. What about it?*

Those Mysterious "Rays."

Apropos of the reported control of aeroplanes, motor-car engines, etc., by a mysterious system of projected rays emanating from Germany, an esteemed correspondent writes me from the Channel Islands enclosing a weird leaflet purporting to describe in general terms some such system, under the title "Vocal Wireless." According to this account, which would appear to have originated in the disordered brain of the mentally deficient, "the main or perpetual current is circulated by instruments set or tuned, each operator in addition wearing concealed instruments under his personal manipulation for independent control of the main line of current, which instruments he can discard at will while still being kept in vocal contact with the other transmitters by the main current—thus having the freedom of his hands for any other occupation and no visible apparatus. These instruments, I am informed, consist of small cylinders in pockets.

"Transmitting to each other, the operators centre upon an individual, introducing the ray or current into the body through the spinal cord, which, flowing up the spine, reaches the brain, where there is a timed pulsation, the rest of the skull being permeated with rays intermittently at the will of the operator. All the vital organs receive treatment with varying intensity, the whole system being thus permeated to the extremities with electricity, which betrays itself by vibration or pulsation, but by an individual being silently worked upon and unsuspecting, is unfelt." Umph! sounds rather like "Radio Rex," or a bad attack of the nightmare.

E.D.A. Conferences.

I congratulate E.D.A. and Mr. Beauchamp on the official announcement, which appears in another part of this journal. It is a real pleasure to note that the conferences are being attended by such increasing numbers as to require a larger hall, and, what is more, it is sure evidence of the energy which is being put into the electrical campaign. It is bound to react to the good of our industry in particular and to the whole country in general. Bravo, J. W. B.! More power to your elbow.

ELEKTRON.

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* The contributor responsible for the above par is evidently not aware of the enterprising way in which this matter has been taken up by the E.D.A. and the magnificent combined show which is to be made. It will be a real eye-opener to the world. —EDITOR.

Questions and Answers by Practical Men.

RULES.

QUESTIONS: *We invite our readers to send us questions, preferably on technical problems that have arisen in actual practice. Questions which we consider of sufficient interest to our readers will either be replied to under "Answers to Correspondents" or replies will be invited from our readers. One shilling will be paid for the question which we select for competitive replies in this column.*

ANSWERS: *A fee of 10s. will be paid for the answer which we consider shows the greatest merit, and 5s. for the one we select as second best. In judging the replies, importance will be attached to clearness and conciseness, as well as accuracy. The Editor reserves the right to make no award, or to accept only one reply if, in his opinion, the answers received do not possess sufficient merit. Competitors desiring the return of their manuscripts, if unaccepted, should enclose stamped addressed envelope.*

Write on one side of the paper only, and if diagrams are sent, draw them on a separate sheet of paper attached to the manuscript. Competitors may adopt a "nom de plume," but, both in the case of questions and answers, the competitor's real name and address must be sent with the manuscript as a guarantee of good faith. No correspondence will be entered into with regard to successful replies. The Editor's decision is final.

Commencing with Question No. 101, a Diploma of Merit will be awarded to the six competitors who win the first or second prize the most times during the next twelve months.

The words "Questions and Answers" or "Q" and "A" should be placed at the top left-hand corner of all letters intended for this column.

QUESTION NO. 173.

I am employed on railway signalling, and I do not understand the construction and principles of operation of the following:—

(1) Track relays, galvanometer type.
(2) Track relays, vane type.
(3) Detection relays, polarised vane type.
(4) Purpose of shading bands on latter.

I would appreciate the details of operation, etc. The tracks are single-phase, 25 to 33½ cycles.—"JACK ALLEN."

QUESTION NO. 174.

Can any reader inform me of the process by which accumulators are treated to enable them to be put on the market in what is known as "a dry and fully charged condition," i.e., only requiring to be filled with dilute acid and to be given a short freshening charge?—"C. R. HARDY."

(Replies to Questions Nos. 173 and 174 must be received not later than January 5, 1924.)

Answers to Questions.

QUESTION NO. 167.

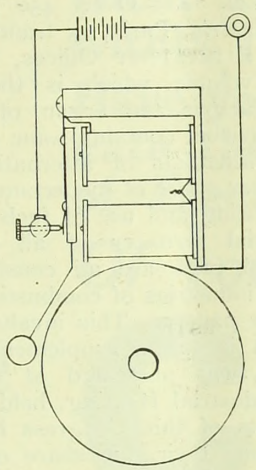
I have a large bell in my works used to signal the "commence work" and "cease work" to my employees. At present it is operated by hand. Can I electrify this so that it will work if I press a button? If so, I would appreciate the details.—"CASHIER."

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REPLIES TO QUESTION NO. 167.

The first prize (10s.) has been awarded to Mr. F. Edwards, 34, Palatine Road, Blackburn, for the following reply:—

Assuming retention of existing gong is required, then the necessary material required will be: Press button, of which there are various types on the market, six Leclanche cells of the large type, and the necessary excitant, either chloride of ammonia or manganese chloride, the type of workshop deciding. If acids are used about the workshop the latter should be used, as the former gives off, in the presence of acid, gases which are injurious to the surrounding metalwork. A number of yards of twin cable, or, if moisture or dampness is prevalent to any degree, it would be wise to employ lead-covered cable. This brings us to "Cashier's" actual requirements. Again assuming the existing gong is permanently fixed to some wall or partition in a central part of the workshop—apparently it is not an electrical workshop—and assuming mechanical knowledge is possessed, an electro-magnet is all that has to be made, and which will be sufficiently strong enough in conjunction with the battery to strike the gong vigorously and repeatedly during the pressing of the button. Attached sketch



and description will be found useful, and when completed could be fitted adjacent to existing gong, so that the armature when attracted would strike the gong. It is usual in practice to provide two bobbins, made up of soft iron cores, usually a bundle of iron wires No. 16 gauge, to form a core ½ in. in diameter. This type is the best for overcoming residual magnetism or sticking of the armature, or, if solid cores are used one end of each should be drilled to receive brass pins, which will serve the same purpose. Cheeks of wood or ebonite should be placed on the ends of the cores, allowing about 1-16 in. of core to project, the overall dimensions of cores being 2 in. to 3 in., diameter of cheeks 1 in. to 1½ in. Consider the solid core type, which will be the easiest to make and handle, with brass pins. The opposite ends of cores should be drilled and tapped for ¼-in. screw for securing to yoke. The cores should then be well insulated with waxed paper or empire cloth. Each core should then be wound with silk or cotton-covered copper wire to a resistance of 50 ohms, or 100 ohms for the two coils in series, 25 ohms if in parallel, this resistance being asked for at the electrical shop, could readily be halved, i.e., 100 ohms without fear of much error. Then each coil could be wound by hand, care being taken in the direction of winding in order to obtain the correct polarity in the cores. Commence winding one core at the end which was drilled and tapped, leaving 2 in. of free end for connection to adjacent coil; wind in a counter-clockwise direction, bringing the free end out at the opposite end to starting. Repeat with second coil, only wind in a clockwise direction, leaving free ends. The coils might be covered with adhesive tape. Two pieces of soft iron well annealed are next required to form the yoke and armature, and shaped as in sketch. Two suitable holes should be drilled in the yoke about 2 in. apart to secure the cores by ¼-in. screws. Two smaller holes should be drilled and tapped in the end of the yoke to carry a flat spring, which might be made from an old clock or gramophone spring, two holes being drilled in each end of the spring for fixing purposes, one end of the armature being drilled and tapped for other end of spring. The centre of the armature should have two further holes drilled and tapped for a second spring, which should be bent a little distance from fixing screws to throw it away from armature, the spring carrying some suitable flat contact at the end on its outer side. The extreme end of the armature should be drilled and tapped to take the hammer. An iron rod, ⅛ in. in thickness, screwed at each end, and bent at a suitable angle so as to strike the gong when the armature is attracted, an iron ball being fixed at one end, the other screwing into the armature. The next item is a brass upright piece of metal slotted, drilled and tapped, with centre to face contact, on the end of armature spring; a contact screw and clamping screw being required for maintaining the adjustment. It would be better to purchase the latter ready-made. The whole might then be mounted on a suitable base board. Two brass terminals provided for making the necessary connection; the two free ends of the coils being twisted together and soldered. The complete electrical connections are shown in sketch.—F. EDWARDS.

No second award is made.

REPLIES TO QUESTION NO. 168.

Note.—The replies to this question were very much below the usual standard, so that no award has been made. The question of rewinding motors for various voltages is one which is continually cropping up in industry, and we must admit that conversions are often carried out at considerable expense which could be avoided if simpler methods were used. We have approached Mr. C. Sylvester, A.M.I.E.E. (whose work upon the subject of armature winding is well known), and he has agreed to write an article for this journal dealing with armature winding from a conversion point of view. This article will be published in the near future.—Editor, ELECTRICITY.

A.M.I.E.E. Exams.—We have received from the Institution of Electrical Engineers a list of the successful candidates at the examination which was held in October last, and congratulate the gentlemen who have thus satisfactorily proved their right to the use of the magic letters A.M.I.E.E. The results relate only to the candidates who sat for the examination in England, including the officers of the Corps of Royal Engineers. The results relating to those candidates who sat for the examination abroad will be published later.

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THE HENLEY DRAMATIC CLUB.

Mr. W. W. Jacobs' very clever farce, "Beauty and the Barge," was performed last Friday evening by the Henley Dramatic Club, at the Cripplegate Institute.

Among first-time appearances on a stage, the following were exceptionally good: Miss Kathleen H. Dunk, as Mrs. Smedley; Miss Hilda Starbuck, as Mrs. Porter; and Mr. R. D. Benjamin, as Herbert Manners. Mr. Benjamin gave a fine performance in a difficult part. His entrance in the first part was perfect, and he deservedly got a "hand" for it. He went "off colour" a little in the second act, and improved again in the third, but he shows decided promise for future performances by the Club, of which the members have proved themselves as skilful in their efforts at entertaining as they are in giving good service and high quality in Henley cables.

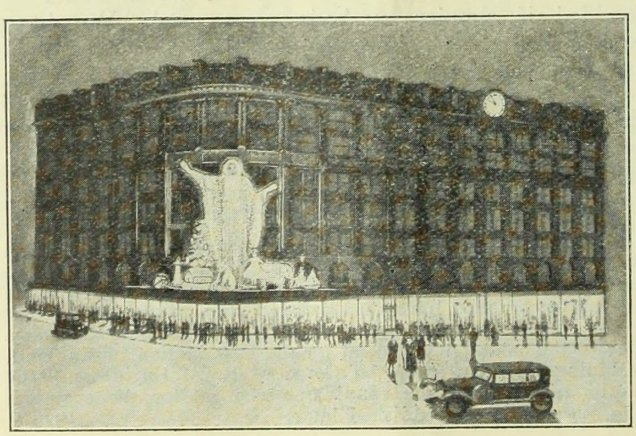
Among those whose second appearance it was, Miss D. R. Josling, as Lucy Dallas; Mr. A. V. Burnett, as John Dibbs; Mr. R. K. Edney, as Augustus Smith; Miss Elsie Savage, as Mrs. Baldwin; Mr. L. F. Cole, as Tom Codd; and Miss Avice Smart, as Ethel Smedley, did well. Of course, those in the cast who have had big experience in amateur theatricals came through with flying colours, including Mr. F. Bettley, as Captain Barley; Mr. T. W. Wheeler, as the liverish, blundering Major Smedley; Mr. J. E. Bradfield, as the gallant and debonnaire Lieut. Seton Boyne, R.N.; and Mr. A. P. Layer, as the pot-house landlord, while Mr. Henry Thornton is to be highly commended upon the production.

Among the large audience, which consisted mainly of the Henley staff and friends of the staff, were Mr. and Mrs. Percy Rosling, Mr. W. J. Potter, Mr. and Mrs. W. F. Bishop, Mr. and Mrs. Hedgecock, Mr. W. W. Bradfield (of Marconi's), and Mr. J. Traxler, manager of Henley's Tyre and Rubber Company.

The next performance, for which a play has not yet been selected, will be produced at the same place on March 7, 1924.

LARGE SIGNS USING "COLOUR-SPRAYED" LAMPS.

One of three day-and-night seasonal signs, some 50 ft. high, is shown in the annexed illustration, which is of Messrs. Lewis's Stores in Liverpool, as they now appear. Similar signs have been erected on the firm's premises in Manchester and Birmingham. By day



"Father Christmas" is represented with a selection of toys about him—all in appropriate colours. After dark an impressive effect is obtained by the use of 4,000 colour-sprayed Osram lamps in each sign. In colour-sprayed lamps the colouring material is sprayed on the bulb by compressed air after manufacture, and, with the enamel-like fluid used, practically any colour can be obtained, with artistic and effective lighting results. Thus, in the sign illustrated, the lamps match in colour the painted surface beneath, this being of wood. The face. hands, beard, teeth, etc., however, are painted on gauze, the lighting here being done by standard 60-watt Osram gasfilled lamps behind.

In the bazaar itself Osram lamps are extensively used for lighting a novel "children's café," a series of tableaux representing scenes from fairy stories, etc.

Reviews of Books, &c.

[Books noticed in this column will be sent from ELECTRICITY *Office to any part of the world, for the published price, plus five per cent. for postage (minimum 2d.), and orders will be appreciated.]*

COMPTES RENDUS DU CONGRES DU CHAUFFAGE INDUSTRIEL. Vol. I. Over 450 pp., illustrated. (*Chaleur et Industrie*, Paris, 25 francs, 28 francs post free; or from ELECTRICITY Offices, 9s. post free.)—This massive volume, which is the July issue of *Chaleur et Industrie*, the organ of the Société de Physique Industrielle, contains some 500 pages, all by engineers and scientists of international reputation, dealing with every phase of fuel economy, including the examination, testing and use of fuels in steam boilers and in industrial furnaces of all kinds. Gaseous, liquid and solid fuels are all considered, and every branch of the "industries of combustion" come within the scope of the papers. This invaluable collection of material, which is to be supplemented by a second similar volume, was presented at the International Congress of Industrial Heating, held in Paris in June last. The fruits of this Congress have, we believe, received less than their due share of attention from engineers, and we have no hesitation in urging those of our readers who are interested in fuel economy to procure this volume. It is a veritable mine of information, the application of which will bring about material increase in efficiency and reduction in working costs. The papers are, of course, in French, and the whole production reflects the highest credit on those concerned. The general scope of the present volume includes the calorific value of fuels, methods and apparatus for the study and control of heating, and four large chapters (33 pages) devoted to practical experience with fuels and furnaces. The second volume deals more particularly with the composition of fuels and the methodical use of heat in industry. Doubtless we shall receive this volume for review in due course.

In introducing the 5th Edition of the CYCLING MANUAL, the publishers, Messrs, Temple Press, Ltd., proprietors of *Cycling*, draw attention to the many revisions and additions that have been made.

Dealing with up-to-date cycles and equipment, it contains many new illustrations and descriptions of the latest improvements.

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Western Electric Co., Ltd.

Advertisement of the Cable Makers' Association, Sardinia House, Sardinia Street, London, W.C.2.

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JUST OUT

A Guide to KINEMATOGRAPHY PROJECTION

By COLIN N. BENNETT.

The present new volume is certain to have a very good reception, for Mr. Bennett is well known throughout the industry. Intended as a handbook for proprietors, manager-operators and operators of picture theatres, the book contains not only full and accurate information on the practical working of machines, but also information and advice on commercial aspects of the subject, such as "How to make up the Weekly Programme," "Choosing and Managing the Staff," "Board of Trade Regulations," etc., etc. Fully illustrated.

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A manual of modern theory and practice, covering the syllabus of the City and Guilds Examination, and specially recommended to candidates for this examination. It is also suitable for candidates for the P.M.G. certificate.

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IMPORTANT.—The next Salemanship Conference will be held at The London School of Economics on Friday, December 14th, 1923, at 7.30 p.m o'clock.

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A chapter on modern rear-wheel quick release devices is also included, and the sections dealing with adjustments and repairs, accessories, clothing, etc., have been improved and amplified.

It is an eminently practical work for the cyclist, and, offered at the revised price of 1s., forms remarkable value. Can be obtained from all principal booksellers and bookstalls, or direct from the publishers, Temple Press, Ltd., 7-15, Rosebery Avenue, London, E.C.1.

BUILDING WITH "RADIOBRIX." A booklet issued by the Metropolitan-Vickers Electrical Co., Ltd., 1s. net.)—Although this book is written primarily as a guide to purchasers of "Radiobrix," it is of use to every wireless experimenter and fills a long-felt want.

Starting with the simplest of circuits, the experimenter is led stage by stage to circuits of a more intricate character. Both crystal and valve circuits are shown.

The diagrams are most complete and lucid, and a page of squared paper opposite each gives place for additional details to be recorded.

Page 65 contains a coupon which, if filled in and returned to the Met.-Vic. Co. with 1s., will bring to the sender 24 additional new circuits as these are published. A dealer's voucher showing the purchase of "Radiobrix" will be accepted instead of the 1s., as obviously the object of the book is to extend the "Radiobrix" sales.

When the new circuit pages are received they may be stuck into the book in the spaces left to receive them.

Notes relating to the various circuits are given, and the opening pages give most useful details which not only apply to the arrangement and grouping of "Radiobrix," but may be very usefully applied to the connections of any receiving apparatus to improve its efficiency.

We heartily endorse the prefacing remark that, "Generally speaking, an interest in listening-in is soon succeeded by an interest in the apparatus employed." "Radiobrix" and their book of circuits enable this new interest to be followed successfully.

The book contains much valuable information to everyone interested in wireless matters, and its price can hardly be an adequate one for the value the purchaser receives.

The number of visitors to the recent Wireless Exhibition who were observed with a copy of the book bore testimony to its popularity.

Meetings.—The next regular meeting of the I.E.E. will be held at the Institution on Thursday, the 13th inst., at 6 p.m. Paper, "Pulverised Fuel and Efficient Steam Generation," by D. Brownlie.

A Great Engineer.—Sir James Kemnal, F.R.S.E., M.I.M.E., M.I.E.E., of Chislehurst, managing director of Messrs. Babcock and Wilcox, has accepted an invitation from the British organisers of the World Power Conference, in London next July, to read a paper on "Steam Generation," a subject about which he knows as much as any living specialist, and a good deal more than most.

L.C.C. Tramways.—We note with pleasure that the Highways Committee of the L.C.C. have decided to place with Messrs. Richardsons, Westgarth and Co., Ltd., Hartlepool, an order for a turbo alternator and condensing plant for the Greenwich Tramways Station, to the value of practically £78,000. This is in face of the fact that lower tenders were submitted by three Swiss firms, and these orders will represent money to be spent on labour in Great Britain and not sent abroad for the benefit of lower-paid foreign workmen.

AN INTERESTING ELECTRICAL EXHIBITION.

The room in which was held the recent electrical exhibition in the premises of Messrs. Waring and Gillow, Ltd., Oxford Street, was specially decorated and lighted with the new white Osram lamps, in artistic silk shades. Round the walls (see illustration) were arranged a number of stands representing different rooms of a house.

In one, representing the engine-room of a country house, was installed a G.E.C. electric lighting set, consisting of oil engine, generator and self-contained switchboard. The kitchen was equipped with "Magnet" cooking devices, and continuous demonstrations of pastry-making and other culinary operations were given throughout the day. The bathroom was complete with "Magnet" calorifier, electric towel rail and gown airers, "Kingsway" massage outfits, hair dryer, etc.



A complete range of "Magnet" heating apparatus, including new designs of cast-iron fires and reflector fires, were shown in another section.

There was also a special window display, demonstrations of glass-blowing by experts from the Osram-G.E.C. Lamps Works, and wireless concerts by means of a "Gecophone" receiving set and loud-speaker.

Trade Notes.

The catalogue of wires and cables which has just recently been issued by the **Edison Swan Electric Co., Ltd.**, is a comprehensive list which will prove of direct value to all electrical contractors, as it gives clear particulars of most of the standard cables in everyday use. It will also appeal to electrical export houses who cater for foreign trade.

"X-ray Reflectors" is the title of a new list just to hand from the **British Thomson-Houston Co., Ltd.** It gives illustrations of the various types of those excellent shop-window accessories, together with details of the special applications for which they can be supplied, and should therefore appeal to a large number of our readers, to whom it will be sent on receipt of proper trade application.——B.T.-H. thermostatic metal is a new duplex metal which is now being placed on the market by the **B.T.-H. Co., Ltd.**, for use in temperature indication, control, or compensation in such devices as oven thermometers, ice machines, thermostat motor ignition control, electric signalling control, etc. The action of the metal may be summed up by saying "it bends with the heat," and as such it should be of direct use to a very large number of electrical-apparatus manufacturers, to whom the list will be willingly sent on application.

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MINING ENGINEERING EXHIBITION AT CARDIFF.

This annual exhibition, which is held under the auspices of the South Wales Institute of Engineers and has in addition the powerful backing of the South Wales Electrical Power Distribution Co., Ltd., was opened on the 29th ult. by Alderman Sydney Jenkins, the Lord Mayor of Cardiff, in the presence of a distinguished company, and, from what we hear, it is proving even more successful than last year's exhibition, which resulted in considerable business for those firms who took part in it. In fact, as the Lord Mayor remarked, the only regret was that Cardiff did not possess a building sufficiently large to house all the exhibits for which space had been requested. As it is, the organising committee have adapted the Drill Hall to the very best advantage, and the inspection accommodation affords comparatively easy perambulation, whilst the various stalls are replete with the latest types of mechanical appliances, especially those that are used in mining operations—appropriately and inevitably so at the chief commercial centre of the South Wales coalfield.

We cannot quote at length the details of the exhibits of the various firms, much of which was entirely concerned with coal-mining and colliery plant, as distinct from electrical apparatus, but we can say that excellent displays were made by such well known firms as the English Electric Co., Meldrums, Hugh Wood and Co., The Igranic Electric Co., Cambridge and Paul Instrument Co., Brookhirst Switchgear, Geo. Ellison, General Electric Co., Gent and Co., Metropolitan-Vickers, and, indeed, most of the leading specialists in such plant and apparatus. General satisfaction was expressed with the way in which the exhibition was managed, and in this connection much credit was due to Mr. C. T. Allan, who, as assistant manager of the South Wales E.P.D. Co., had much to do with the organisation and general control. He must feel pleased with the result of his arduous labours.

Various Items.

Tenders Accepted.—The L.M. and S. Rly. Co. have accepted the tender of the Siemens and English Electric Lamp Co., Ltd., for a large number of Siemens metal filament train-lighting lamps.

Country House Lighting.—A lecture on this subject (with lantern illustrations) will be given by Mr. J. S. Highfield, M.I.E.E., to the members of the National Association of Supervising Electricians at the St. Bride's Institute, E.C.4, on Tuesday, December 11, at 7 p.m., and is certain to be most interesting to those fortunate enough to be present.

B.E.X. Overseas Advertising.—The Dorland Agency, Ltd., 16, Regent Street, London, S.W.1, have been appointed by the British Empire Exhibition as sole agents for all overseas advertising. Exhibitors who wish to have their advertising in the overseas Press associated with the announcements of the Exhibition should communicate with the Agency.

Financing Italy.—Senator Prof. Achille Loria, President of the Foreign Financing International Institute, Via Condotti 91, Rome, invites English engineers and financiers to take part in a meeting to be held in Rome next January for the purpose of laying the foundation of that co-operation of foreign capital in Italy which, besides causing relations to become closer between her and other countries, is bound to facilitate the work of reconstruction in Europe, so much to be desired. The meeting is under the official support of many of the leading members of the Italian Parliament, and it is to be hoped that it will help considerably towards the improvement of trade conditions generally throughout Europe.

Plant Wanted.—The Taranaki Electric Power Board invite tenders for the supply of generators and switchgear.——The City of Toronto Dept. of Works invite tenders for one electrically driven air compressor, with accessories, and one separator.——The Harbour Trust Commrs. invite tenders for the supply and installation on runway tracks in the wharf shed at No. 6 Berth, Darling Harbour, Sydney, N.S.W., of one 5-ton electrically operated overhead travelling bridge crane. Particulars from the D.O.T., 35, Old Queen Street, London, S.W.1.

Personal.—Mr. Raymond J. Mitchell, M.I.E.E., M.I.Mech.E., M.I.A.E.; until recently chief engineer of Electricars, Ltd., and Edison Accumulators, Ltd., has joined the staff of Messrs. Ransomes and Marles Co., Ltd., ball-bearing manufacturers, Newark-on-Trent. Mr. Mitchell has been identified since the year 1912 with the development of accumulator electric road vehicles, on which subject he has, during this period, read a number of papers before engineering societies, in addition to having contributed numerous articles to the technical Press.

Social.—We have received from the Siemens and English Electric Lamp Co., Ltd., of 38/39, Upper Thames Street, London, E.C.4, a programme of the staff social which was held on Friday, the 30th ult. It is a very humorous and excellently arranged programme of what must have been a most happy and sociable entertainment, and we do not think we can do better than quote the last line of the message printed on page 10: "May the best of good luck attend both our firm and our socials." Most certainly J. F. C. and his assistants have a broad gift of humour, which must have added much to the pleasure of the evening.

Meetings.—The I.E.E. (Scottish Centre) will meet at the Rooms, 207, Bath Street, Glasgow, on Tuesday, the 11th inst., at 7.30 p.m. Paper: "Pulverised Fuel and Efficient Steam Generation," by D. Brownlie.——The following informal meetings of the I.E.E. have been arranged for up to February 4, 1924, viz.:—December 17, 1923: Subject, "Students in Electricity Undertakings." Discussion to be opened by G. R. A. Murray. January 7, 1924: Subject, "Troubles Experienced with Domestic Electrical Appliances." Discussion to be opened by J. W. Beauchamp. January 21, 1924: Subject, "Broadcasting." Discussion to be opened by E. H. Shaughnessy. February 4, 1924: Subject, "Storage Battery Troubles." Discussion to be opened by F. Crawter. They will all be held at the Institution at 7 p.m.

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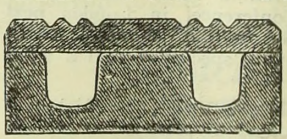
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A POPULAR SCIENTIFIC WEEKLY JOURNAL
ELECTRICITY
A PRACTICAL TRADE JOURNAL

DECEMBER 14, 1923.

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THE LOCHGELLY IRON AND COAL COMPANY'S ELECTRICITY GENERATING STATION AT NELLIE PIT, LOCHGELLY, FIFE.*

This power house is one of the elements of a power distribution scheme, planned in accordance with the diagram Fig. 1, to supply power to all parts of the coalfield of the company. Steam raising will be confined to two of the pits, each of which will have its electric power station; the other pits will be "all-electric." The present extent of the finished work is shown on the plan, Fig. 1: this includes the Nellie Pit Power Station and seven transformer sub-stations The proposed second power station at Minto Colliery and three further sub-stations are also indicated.

The main overhead transmission is by three-phase alternating current, 50 periods, 3,000 to 3,300 volts, with star point earthed at the power house through a resistance. The secondary power pressure for the motors is 500 to 525 volts and for lighting services is 200 volts.

The generating units at the Nellie Pit Power Station include two reciprocating sets and one turbo-alternator. The former are two 375 r.p.m. Belliss and Morcom self-lubricating three crank triple expansion engines, direct coupled to 500 kilowatt Bruce Peebles alternators having 200 volt exciters on the same shaft. One ejector condenser with centrifugal injection pump, by S. Bullock and Co., capable of dealing with the steam from the two sets, on average loading, at a vacuum of 26 in. relative to bar: 30 in., and injection water at 70 degs. F.

The turbo-generator is of 1,000 kilowatt, 3,000 r.p.m. Fraser and Chalmers-General Electric mixed pressure, having a 100 volt exciter on the same shaft. This set is combined with an ejector condenser with centrifugal injection pump, by S. Bullock and Co., capable of dealing with full load, on live steam, at a vacuum of 28 inches: and with full load—half on live and half on exhaust steam—at a vacuum of 27 inches, relative to bar: 30 inches, and injection water at 70 degs. F.

The generator switchgear consists of oil switches having automatic reverse tripping features. The feeders are controlled similarly, but the switches are fitted with inverse time-element overload and out-of-balance trips.

Two Tirrill regulators are installed, one in the field of the two reciprocating sets and one for the turbo set.

The steam-raising plant consists of four Badcock boilers working at 160 lb. pressure and fitted with chain-grate stokers, motor driven, suitable for burning of washery residue. Each boiler has a maximum evaporative capacity of 8,000 lb. per hour. Integral superheaters are fitted, designed to add 100 degs. F. to the steam temperature. The boilers operate under natural draught.

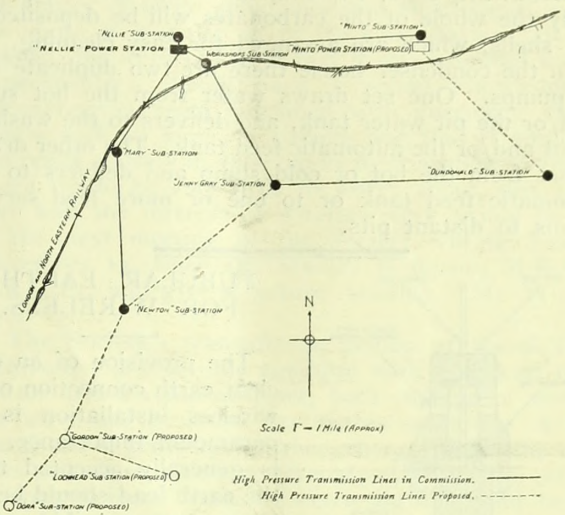


FIG. 1.
GENERAL PLAN OF THE ELECTRICAL DISTRIBUTION SYSTEM OF THE LOCHGELLY IRON AND COAL CO., FIFE.

The discharge from the condensers is lifted by a centrifugal pump from the hot sump below the condenser house floor level, and discharged through spray nozzles into a cooling pond. The difference between the "static" and "working" water levels in the pond and sump is about 10 inches. The whole of the condensed steam of the colliery finds its way into the general body of the condensing and feed water through the condensers.

There are three distinct services of make-up water, one—the most abundant—requiring rather heavy, and the other two slight treatment for hardness.

The three services require practically equal treatment in order to flocculate and separate the small quantities of emulsified oil which finds its way into the water system through the exhaust steam from winding and other surface engines. Flocculence will be obtained by means of alumina ferric, and separation by means of wood-wool and sand filtering. The feed water treating plant is not yet installed.

The feed water and heat accumulator systems are combined. The heat accumulator consists of two interconnected shells used in the well-known method for the storage of heat from intermittent steam, such as winding engines, by injection of the stem below the water level. Steady steam is admitted to the space above the water level.

The feed water system will in some respects be novel. The feed water supply pumps will serve, through a ball cock, an automatic feed tank, which in turn

* The *Mining Electrical Engineer.*

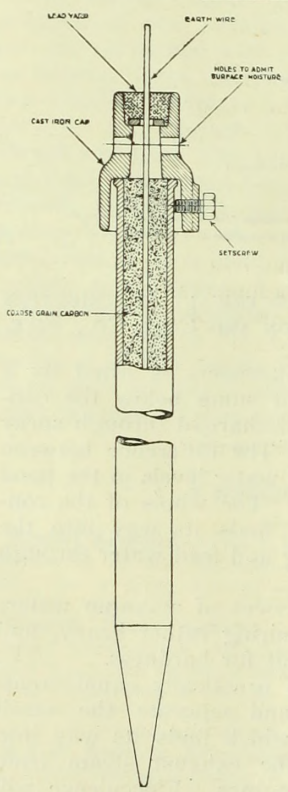
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will be connected to the water space of the heat accumulator shells. The water in this tank, and in the heat accumulators, will be kept at a certain level by the admission ball cock; and for safety reasons, two inverted ball cocks will be provided to void water in the event of the admission ball cock not functioning properly.

The feed water will be taken by gravity from the accumulator shells, through a ball cock, to the treatment plant. Owing to the water capacity of the accumulator shells, at full demand, the feed water will take about an hour to traverse the shells. During this period the water will be maintained at a temperature of about 214 degs. F., and, as a consequence, practically the whole of the carbonates will be deposited in the shells, which are arranged for easy cleaning.

In the condenser house there are two duplicate sets of pumps. One set draws water from the hot sump and/or the pit water tank, and delivers to the washery plant and/or the automatic feed tank. The other draws either from the hot or cold sump and delivers to the automatic feed tank or to one or more feed service mains to distant pits.

TUBULAR EARTHS FOR WIRELESS.



The provision of an efficient earth connection on a wireless installation is of paramount importance. It is generally accepted that the earth lead should be as short as possible, but where the earth connection is made to a water supply pipe a long length of wire is often unavoidable. The "Gecophone" Hedges Patent Tubular Earth, illustrated in the sectional diagram, provides an easy method of making an efficient "earth" quite close to the set. This consists of a 3 ft. length of specially pointed tube provided at the top with a cap secured to the tube by a set screw.

The earth wire from the set is threaded through the brass washer provided for a distance of 3 ft., and then through the iron cap. If enamelled or insulated wire is used the insulation must be removed to the full length that projects through the cap. The cast iron cap is then filled with the lead yarn provided with the outfit and carefully tamped into the recess at the top of the cap by means of a hammer and punch. The pointed end of the tube is then driven into the ground at the selected point (preferably at least 3 ft. from the walls of the house) till the top of the tube is just below ground level. The wires should then be inserted into the tube, and the carbon provided poured into the tube to fill it to the top, a small quantity of water being added to moisten the carbon. The object of this carbon is to insure a good earth connection even after the metal portion of the apparatus has, in the course of years, rusted away. Finally, the cap is secured to the tube by means of the set screw. A leaflet, No. 3125, has just been issued by the General Electric Co., Ltd., describing this device, and copies can be obtained upon application to Magnet House, or any of the company's numerous branches.

A "C.T.S." COMPETITION.

The St. Helens Cable and Rubber Co., Ltd., of Slough, who hold a world-wide reputation as the inventors of the famous C.T.S. (Cab Tyre Sheathed) Wiring System, have arranged with the proprietors of ELECTRICITY to offer a duplicate series of prizes for the three articles sent in by competitors in (*a*) the United Kingdom and (*b*) the British Colonies, which, in the opinion of the competition judge, or judges, most clearly and practically explain the advantages and disadvantage of the C.T.S. system for wiring and other purposes. The terms of the competition are as follows:—

1. The length of the article not to exceed about 1,000 words, or, say, two columns of ELECTRICITY, and to be written on one side of the paper only. Clearness of wording should be aimed at, and unnecessary flattery will be deemed a drawback.
2. Diagrams are not essential, and, if used at all, should be as few as possible, owing to the space limit.
3. There are no special restrictions as to competitors. The desire is to appeal to as wide a circle as possible, and for that reason the prizes will be in duplicate in order to enable colonial competitors to have an equal opportunity of expressing their views.
4. The papers sent in will be judged by Mr. W. E. Highfield, M.I.E.E., President N.A.S.E., and a member of the I.E.E. board of examiners, and no appeal can be made against the decisions arrived at.
5. The prizes offered are:—

First prize	... ...	Five Guineas.
Second prize	... ...	Three Guineas.
Third prize	... ...	Two Guineas.

   and the St. Helens Company would at their discretion award consolation prizes up to one guinea each where they consider it suitable.
6. It is part of the contract that all competition papers, including the actual prize-winning papers, become the property of the St. Helens Cable and Rubber Co., Ltd., and no application for their return can be considered.
7. Competition papers must be addressed to

   "C.T.S." Competition,
   ELECTRICITY Office,
   36, Maiden Lane,
   London, W.C.2,

   and those from the U.K. must be delivered not later than the last post of January 7, 1924, while those from the Colonies must be delivered by March 31, 1924.

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Mr. J. W. Wheeler pointed out that the authorities are spending large sums on the special education of sub-normal children; while this discussion had indicated that many of them must be within easy aid of modern apparatus at very considerably less expenditure.

Messrs. M. D. Hart, F. S. Robertson, P. G. Pettifor, A. A. Williams, W. Day and J. Coxon also spoke, and Mr. Balbi replied to the questions raised.

THE RELATIONS BETWEEN DAMPING AND SPEED IN WIRELESS RECEPTION.*

By L. B. TURNER, M.A., Member.

Part I. of this paper is devoted to an examination of the ordinary method of recorder working in wireless telegraph receivers, as affected by the damping of the receiver circuits. After a résumé of the significances of the decrement of any oscillatory system, its bearing on the possible speed of recording Morse signals is investigated. The quality (approach to correct Morse "shaping") is estimated from calculated curves of amplitude of oscillation set up in the receiver by the incoming dots and dashes constituting the letter "l." By comparing several such curves, a minimum practical value is found for the product of frequency and decrement and duration of Morse dot. The relation between speed of signalling and the requisite transmitter power is then investigated. Part I. concludes (Section 5) with a summary and discussion of the results arrived at.

In Part II., an improved method of reception, called "receiver curbing," is described and analysed. An estimate is made of the improvement obtainable, and practical circuits are given for putting the method into effect.

AMPLIFIERS.

On Thursday, November 15, Capt. Hollingworth, M.A., B.Sc., lectured on this subject before the members of the Manchester Wireless Society. He commenced with the suggestion that he would endeavour to prove why amplifiers did not amplify, and by a series of lucid explanations succeeded in pointing out in a very non-technical manner the several drawbacks which prevent users from obtaining the full percentage of amplification which is in most cases expected. In the lecturer's opinion the greatest enemy of amplifiers and, incidentally, the experimenter, is "stray capacity" in the circuit, and it was very clearly illustrated how this could be overcome to a great extent, but even then only a small percentage of amplification could be expected. If an amplifier does not work out in practice as in theory, then it is proof conclusive that it is the wrong theory. In the design of transformers (L.F.) the intercapacity action between the windings was far more important than the magnetic flux. Invariably an amplifier will not amplify until it is forced, and then it overdoes it to such an extent as to cause distortion. In using three stages of L.F. it was the rule to expect a 5 to 1 step-up in each case, but it was considered lucky to obtain a maximum total of 25. The only way to obtain more amplification was to employ mort H.T. and negative grid bias, and this meant that the L.F. transformers should be of robust construction and of good insulation resistance. Correct grid potential on rectifier was essential, also the grid-leak was a most important factor, and more attention should be paid to the construction of components rather than the pretty effect of busbar wiring. The most important circuit of all amplifiers is the resonance or aerial circuit, and this should be of the very lowest resistance, and preferably nothing finer than 20 S.W.G. should be used. One incident was mentioned in which it was stated that the best reception had been obtained on a single turn of thick wire as aerial coil and a 1 MFD condenser in parallel, though this was admitted to be rather on the extreme side, but certainly a very useful reminder that the theory of large inductance and small capacity was not quite so popular as in the early days. In conclusion, the lecturer stated that it was essential that all experimenters should have a sound knowledge of alternating currents combined with unceasing experiments with all kinds of circuits and that if amplifiers did really amplify as they ought to according to theory, there would be very little to worry about, and therefore half the interest of wireless work would be lost.

The next meeting of the Society will be held on December 14, when Dr. Stanley Hodgson, M.R.C.S., L.R.C.P., will give a lecture, entitled "My Wireless Life."

The Society's transatlantic station at Sorrel Bank, Pendleton, is now fully equipped with a 10-watt transmitter and a 1,000-watt set, both capable of working on wave-lengths from 150 metres upwards. A four-valve set is provided for the general use of the members and also a six-valve heterodyne set for the purpose of long-distance work. Electric lighting and heating have been installed and an aerial erected on 60 ft. masts for the purpose of winter experiments. Several types of aerials have been constructed, and these can be raised and lowered at will, depending upon the particular experiments in view. The room is suitably equipped for all-night sittings and every convenience is provided against cold, and even the tired members can turn in on the Army camp-beds provided for this purpose. Reports on the winter experiments will be published in our columns from time to time.

POLITICS AND THE ENGINEERING INDUSTRY.

A circular has been issued from the headquarters of the British Engineers' Association, giving the results of the questions which had been put to the members by the council, namely:—

"Do you wish this Association to support the Prime Minister's policy of protecting our manufacturing industries in the home market?"

And the following question to non-members, namely:—

"Are you in favour of the Prime Minister's policy of protecting our manufacturing industries in the home market?"

To these queries 1,094 replies were received, divided as follows:—

Yes	81.8 per cent.
No	15.4 per cent.
Indefinite	2.7 per cent.

and we think that this heavy majority in favour of the Prime Minister's trade policy should be of direct interest to a very large number of the readers of this paper.

* Summary of paper read before the I.E.E.

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B.E.X. EXTERIOR LIGHTING.

The artificial lighting of the grounds and buildings of the British Empire Exhibition has received most careful consideration, and a scheme has been approved which, it is confidently anticipated, will produce not only a more pleasing, but also a more striking, effect on the public, as the psychological effect will be on a grander scale than has hitherto been effected. Consider, for example, the effect on the mind of viewing beautiful buildings, well known in daylight, by the light of the sunset or by moonlight. The complete change in appearance is so pleasing that people will go to much inconvenience to view the changed appearance. The purpose of the present scheme is to bring these effects to the public.

For the ground lighting, as apart from the buildings, it has been decided to use numerous light sources of low intrinsic brilliancy, but sufficiently powerful to produce a high degree of illumination without any glare or dazzle, and the lamps are, therefore, contained in numerous lanterns, each having a surface area of over 1,500 sq. inches. Thus, powerful as they are, they have a brilliancy less than that of a candle flame, and therefore produce no unpleasant effect. This light does not interfere with the possibility of changing gradually to a colour the illumination of the buildings and other beautiful objects which appear in the vista. For the buildings themselves, the lighting scheme is designed to produce a natural result by utilising the concentrated light of lamps placed on the roofs, and in positions where they are invisible to the public. They will illuminate the part of the buildings to the skyline, so that each building will stand out in colour against the darkness of the sky.

The final result aimed at is that instead of various colours spread about, all the faces of the buildings will gradually melt from one colour to another, thus showing them up in a new light and producing a physiological effect the extent and beauty of which it is impossible to conceive.

The central lake is to be lighted from floating gardens. Lights of varying colours will pour on to the surface of the water and convert it into a part of the general colour scheme. It is, therefore, to be hoped that this exhibition will prove a striking example of the way in which science has made not only electricity, but electric light the servant of man. At any rate, we can have the utmost confidence that Mr. Haydn T. Harrison, who is the illuminating expert to the exhibition, will do his utmost to make the lighting scheme a magnificent advertisement for the British electrical industry.

A NEW DEPARTURE IN FLOODLIGHTING.

We give herewith illustrations of (1) the I.E. 2/86 G.E.C. Floodlight, and (2) the actual floodlighting effect at the new front of the Army and Navy Stores in Victoria Street, S.W.1. This front was designed by Sir Aston Webb, and as it was desired that such an attractive feature should not be lost sight of at night, the illuminating department of the G.E.C. was consulted, Sir Aston Webb explaining that he did not wish any fittings to be visible, and suggesting that the illumination should be carried out from below the pavement. Pavement lights were therefore put in, and under these Osram gas-filled electric lamps of the projector type were fitted, equipped with specially designed reflectors, with the result that the whole front is now suffused with soft, white light, and the absence of glare and visible fittings make the installation specially attractive on a street which is otherwise rather dark and gloomy.

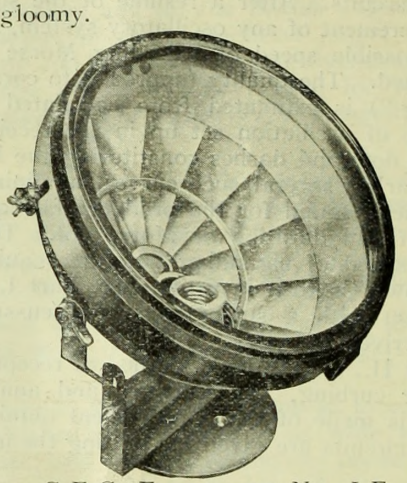


FIG. 1.—G.E.C. FLOODLIGHT NO. I.E. 2/86.

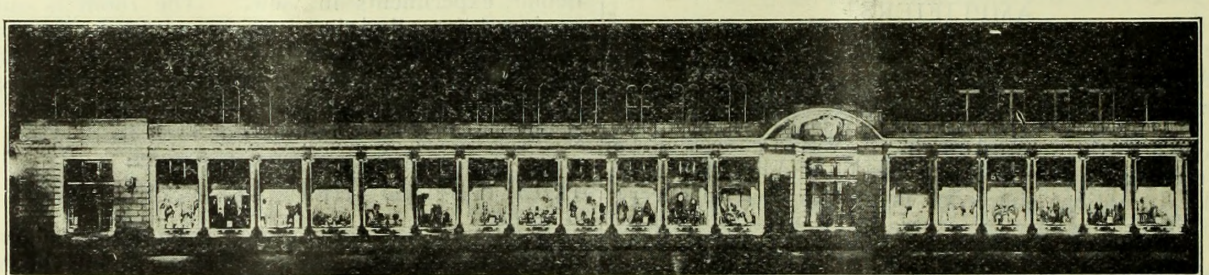


FIG. 2.—G.E.C. FLOODLIGHTING AT THE ARMY AND NAVY STORES, VICTORIA STREET.

Another feature of this most artistic frontage is the introduction of the Strozzi lantern, manufactured in cast bronze by the G.E.C. This is fitted with a concealed floodlight in the top and illuminates that part of the building which would otherwise be in shadow, cast from the lantern itself.

Extending the Imperial Cable System.—At the recent Imperial Conference it was stated that the All-British chain of submarine telegraph cables was to receive an important addition in the shape of a new cable from Turk's Island to Barbados, whence it would bifurcate to Trinidad and to British Guiana. The total length of new cable amounts to 1,700 nautical miles, and the order has been placed with Messrs. Siemens Bros. and Co., Ltd., who have contracted to manufacture and lay by next summer a cable embodying all the latest improvements.

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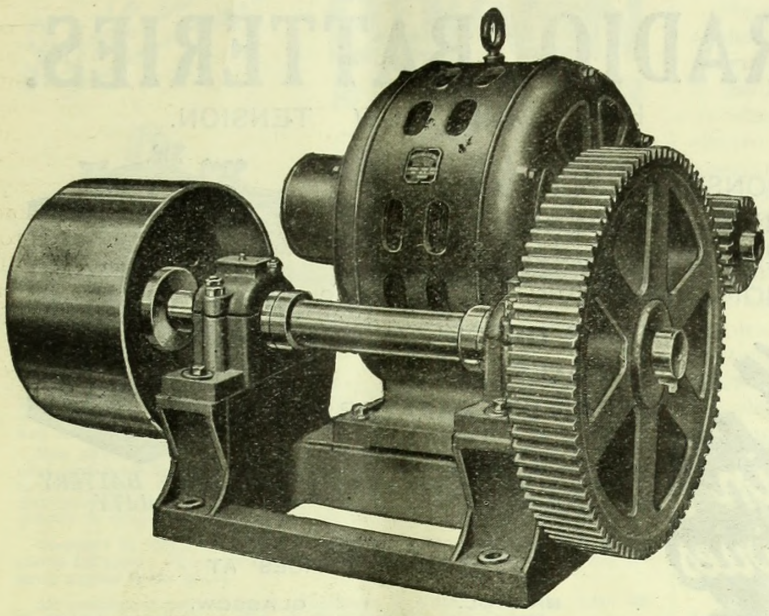


Illustration shows a 40 B.H.P. Standard Back-gear Motor.

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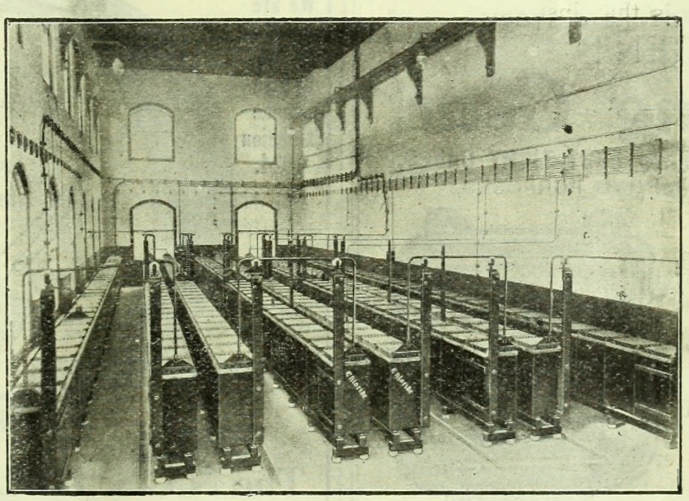
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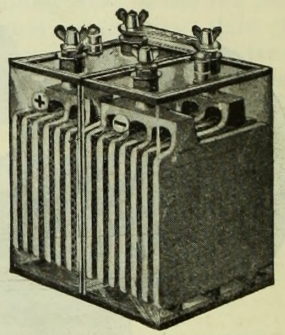
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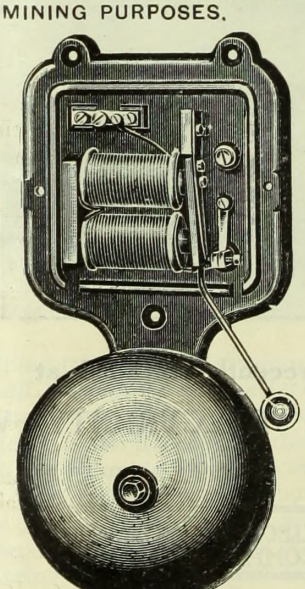
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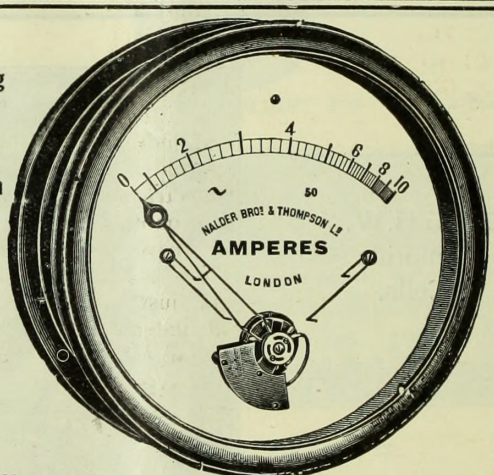


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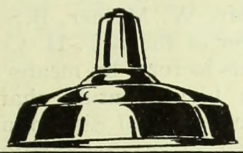
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TO OUR READERS.

ELECTRICITY is published every Friday, and, if ordered, is on sale at the principal Railway Station Bookstalls and Newsagents on that day. It has a very large sale throughout the United Kingdom, as well as in the British Colonies and Abroad.

New advertisements for the displayed columns and alterations to existing ones must reach the publishing office not later than first post Tuesday morning, in order to be in time for the issue of the following Friday. This is important. Rate quoted on application. Subscription : 13s. a year, 6s. 6d. half-year, 3s. 3d. a quarter in advance, postage prepaid in the United Kingdom and abroad.

Questions to which an answer is required must be accompanied by a 1½d. stamp for reply. When considered of sufficient interest, the answer will probably appear in the paper.

All remittances payable to the Publishers, S. RENTELL AND CO., LTD., 36-39, Maiden Lane, London W.C. 2. Telephone No. 2460 Gerrard.

Current Topics.

That Christmas Gift.

By the time these lines appear in print, those of my readers who have not yet had the opportunity or leisure to enjoy a round of the shops, so well worth visiting at this season, will doubtless be considering their choice of suitable gifts for relatives and friends. In this connection all associated with the electrical industry should make a point of not only supporting that industry by choosing something attractive in the electrical field, but, furthermore, by so doing, add their quota of indirect propaganda directed towards the more widespread use of electricity in the home. There is an ample choice of highly appropriate presents just now. What, for instance, could be better calculated to retain the affections of a maiden aunt than an electric kettle, or one of those handly Xcel table cookers; or, if the recipient be of the male persuasion, an electric cigar lighter or shaving-water heater?

Mother, who appreciates that early morning cup of tea these cold winter days, will be delighted with an Xcel electric kettle, and her pride in her household will be augmented by the presentation of one of the many electric vacuum cleaners which lessen the daily drudgery. The boys of the establishment, if mechanically inclined, or addicted to the latest craze for constructing wireless sets, will appreciate such gifts as a pair of Claritone headphones, or one of the equally popular loud-speakers bearing this famous trade mark. These are components which are rather beyond the capabilities of the amateur mechanic to manufacture for himself in the home workshop. For those of lesser means there is a host of well-designed components of British manufacture on the market to choose from, and, incidentally, an electric soldering iron of reputable make is not a bad Christmas gift for the wireless constructor. It is calculated to simplify considerably the making of circuit connections.

There are quite reliable and moderate-priced electric soldering irons on the market to-day, which are guaranteed for a moderate period of use. An example is the Xcel, just recently listed by the makers of these well-known domestic electric appliances. Grown-up sisters would doubtless appreciate the thoughtfulness underlying an electric hair dryer, or one of those neat electric irons which make ironing a pleasure. At least one iron on the market carries a guarantee for life, and is, withal, moderate in price cost as well as beautifully finished. I have only mentioned a few of the hundred and one things of an electrical order which could, and do, constitute highly acceptable Christmas gifts, more particularly in those households where current is already available. If the recipient's house is not wired for electricity supply, there is an opportunity here for making a convert in the New Year, either by the gift of certain essential fittings or, if the donor happens to be a contractor, by offering to carry out a certain proportion of the necessary wiring, free of all charge, as a Christmas donation.

This is by no mean an impracticable suggestion; I happen to know a man who received a wedding present of a similar character. Among his friends was a leading painter and decorator in a large way of business in the same locality, and, when my friend announced his intention of joining the happy throng of married and settled, the friend made the novel offer of redecorating and painting his newly acquired house from basement to attic, leaving the choice of papers and colour scheme to the bridegroom without reservation as to price. The result was that the couple started housekeeping in a clean and tastefully decorated home whilst enjoying all the anticipatory delights of choosing their own paper patterns, enamel and paint, and seeing the scheme take shape as the workmen proceeded with the contract.

A similar principle in present-giving, whether for Christmas, birthday or any other occasion for gift-making, would be involved in free wiring or the presentation of certain fittings, and at the same time the donor would have the satisfaction of realising that he was making another convert to electricity for the home. I offer the suggestion to contractor and dealer friends as a solution to what is often a very difficult and perplexing problem: What shall we give them?

Those Ashes.

Here is another—I believe novel and, at all events, seasonable—suggestion. The ever-growing problem of power station engineers in charge of large super-power stations in our principal provincial cities and towns is the effectual disposal of boiler-house waste, ashes and clinker. Now we are enduring the annual mud-bath, which usually obtains for the present and succeeding two months of every year, and walking degenerates into a veritable "grovel" through inches of greasy, sticky mud wherever the efforts of the paviour have so far failed to penetrate. It is not so bad in the civilised centres of our larger towns, but in the outskirts and suburban districts, where the municipal and

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speculative builder has concentrated on the erection of "homes for heroes," without a thought as to the means of access to either front door or back, getting about, either afoot or awheel, is a particularly dirty experience.

I never have been able to understand how it is that municipal councils will permit roads and streets to remain uncompleted for years and years after the builder has done his work on the houses which front thereon. Surely the first requirement of a new row of houses is reasonably firm, dry and clean roadways to the front doors at all events, yet there are literally hundreds of miles of suburban property in all our larger towns where the unfortunate tenants have to wade through mud almost up to their knees when the weather is really inclement, to gain access to their houses. Tradesmen's carts and motor vehicles frequently get into difficulties in these morasses, and only to-day I lent a helping hand to a youth pulling a heavily loaded handcart to enable him to reach firm ground from the immediate frontage of a row of houses which were erected long before 1914. There certainly ought to be a drastic law compelling both builder and municipal authority to complete a roadway within a reasonable period of the completion of the houses therein, under heavy pains and penalties.

I am rather getting away from the original subject matter of these paragraphs, which was to suggest a useful destination for many tons of the dry cinder ash which power station engineers are at big expense in carting away to distant tips. During the muddy months, as we may aptly term them, much costly cartage could be saved, and a double purpose served, by dumping a respectable tonnage of this very excellent material on some of the miles of superlatively muddy roadways and paths which abound on the outskirts of provincial towns and cities, especially in the industrial areas. There is nothing like cinders for dry-surfacing a footwalk or roadway. Being porous, they absorb the surface moisture, which gradually filters away into the subsoil, leaving the top surface dry and clean to the foot passenger. In the district above referred to, where I came across the bogged handcart, several large steam tractors are to be seen daily taking a considerable tonnage of power-station ashes to a far-away dump, whereas they could be far more effectively and profitably dumped within a mile of the boiler-house which produces them. Will power station engineers please note, and establish much-needed contact with city surveyors.

ELEKTRON.

Motor Shipping.—Considerable interest has centred round the question of motor shipping during the past month, in view of the fact that an order was placed for a 20,000-ton oil-engined liner, and a Government guarantee given for £1,800,000 to the Bank Line for the construction of nineteen motor cargo ships under the Trade Facilities Act. Details of both these items are given in the current issue of the *Motor Ship*, as well as of the large amount of electrical apparatus and auxiliary machinery which is now being installed in these ships as they are being built. Careful tests have shown considerable economics in the electric drive as compared with steam drive for the auxiliary machinery, and this is, of course, much to the advantage of the electrical industry. There is no doubt that motor ships are making rapid progress in the commercial fleets of the world.

THE JUNIOR INST. OF ENGINEERS AT THE B.T.-H. CO.'S DEMONSTRATION ROOMS.

The Junior Institution of Engineers visited the demonstration rooms of the British Thomson-Houston Co., Ltd., on Friday evening, the 7th inst., to hear a lecture and witness demonstrations of industrial and shop-lighting effects. The lecture was given, and the demonstrations carried out, by Mr. W. Millner, B.Sc., A.M.I.E.E., illuminating engineer of the B.T.-H. Co., Ltd., and during the course of his lecture, by means of lantern slides, he illustrated a few scientific charts dealing with the acuity of vision, speed of discrimination, sustained vision and speed of accommodation. The curves on these charts are the result of tests carried out in several industries, and pointed to the fact that one's ability to see was considerably increased under high intensities of illumination. Mr. Millner also put forward some very interesting figures obtained from actual tests in various industries, which proved that production was considerably increased when higher intensities of light were used. The visitors were impressed with the show-window demonstration, and appreciated the colour effects as an attractive medium. After the lecture and demonstrations, a discussion took place between the members upon the lighting of offices and industrial interiors, the lighting of drawing offices being discussed at some length.

"RELAY" AUTOMATIC EXCHANGES AT WEMBLEY.

A wonderful system of internal communication is being installed by the Relay Automatic Telephone Co., Ltd., to connect the buildings of all the Dominions and Colonies with each other, and with the Exhibition headquarters. They are arranging for over two hundred lines. The switchboard, on which the company is at present working, will be accommodated on Stand S 778 in the Building Section. It will be open to the inspection of visitors, and should, in view of the general adoption of automatic telephones, prove of considerable interest, as comparatively few people have seen an automatic exchange in operation. Work on installing the lines was begun on the 1st inst., and the whole system will be ready for use on January 1st.

In addition to the exchange in the Building Section, the Relay Company is occupying a site 500 sq. ft. in the Engineering Section, where latest models in public exchange, private automatic exchange and private automatic branch exchange will be shown in operation. A private automatic branch exchange is also being exhibited in the British Government Pavilion.

This system is now being widely used in India, South Africa, Brazil and in many of the countries of Europe, as well as being already in operation at Marconi House, the London Hospital, Australia House, the Bank of England, Paddington Station and many other of the big buildings in London and elsewhere. What is more, it is the only one which will work at sea.

Tenders Accepted.—The tenders of Messrs. Daniel Adamson, Ltd., Dukinfield, Manchester, have been accepted for the supply, delivery and erection of an automatic sewage ejector plant for Montreal, Canada, and Llandudno, North Wales. In both cases they will be driven by automatic electro-pneumatic air compressors.

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DIARIES FOR 1924.

For well over one hundred years diaries have been published by Chas. Letts and Co., and for 1924 a more extensive series is offered than has been the case hitherto. That Letts' diaries are conceived on lines which appeal to the public is evidenced by the fact that during recent years nearly two million were produced each season, a circulation accounted for by the very varied nature of the books, the quality of the paper and printing, and the strength and artistry of the bindings, etc. Besides pocket and desk diaries of different sizes, there are many catering for the needs of particular sections of the community; for instance, there are the schoolboys' and schoolgirls' diaries, scouts' and girl guides' diaries, housewives', gardeners' and poultry keepers' diaries. This year two new ones make their appearance—the A.A. Motorists' Diary, which is published jointly with the Automobile Association, and the Model Engineers' Pocket Diary and Notebook. This contains much information of direct interest to model engineers, and experimental mechanical and electrical workers. It is edited by Mr. Percival Marshall, and, being published jointly by Chas. Letts and Co., and Percival Marshall and Co., we expected to find it of all-round excellence. Nor were we disappointed on studying it.

PULVERISED FUEL AND EFFICIENT STEAM GENERATION.*

By DAVID BROWNLIE, B.Sc. (Hons.) Lond.

The paper, which was illustrated by sixty specially prepared lantern slides, is a most detailed consideration of the whole question of the application of pulverised fuel to steam generation, more especially from the point of view of the "Lopulco" system for large water tube boilers and the efficient generation of electricity in power stations. By the courtesy of Mr. W. R. Wood, of the Underfeed Stoker Co., Ltd., very extensive data is given, part of which has not before been published, relating to the pioneer large pulverised-fuel fired electricity station, the "Lakeside" station of Milwaukee, together also with a description of the River Rouge power plant of the Ford Motor Co. at Dearborn, Detroit, using pulverised fuel and blast furnace gas, and which the author stated was the most remarkable power plant in the world. For comparison, by the courtesy of Mr. R. B. Mitchell, there were given the figures of the Dalmarnock electricity station, Glasgow, one of the largest and most modern and efficient in Great Britain, of course working with mechanical stokers. A thorough consideration then followed, based on these actual results, of the advantages and disadvantages of pulverised fuel. The paper contained very numerous columns of statistics, figures, diagrams, and illustrations, the slides including twenty views of the Ford plant at Detroit, and about a dozen of Lakeside, Milwaukee.

One of the chief impressions of this paper is the urgent necessity for the adoption in Great Britain of improved scientific methods, particularly in connection with the production of cheaper power, and the application of pulverised coal to steam generation is a striking example of the way we are lagging behind the United States.

* Résumé of paper read and discussed before the I.E.E. on Thursday, December 13, 1923

Questions and Answers by Practical Men.

RULES.

QUESTIONS : *We invite our readers to send us questions, preferably on technica problems that have arisen in actual practice. Questions which we consider of sufficient interest to our readers will either be replied to under "Answers to Correspondents" or replies will be invited from our readers. One shilling will be paid for the question which we select for competitive replies in this column.*

ANSWERS : *A fee of 10s. will be paid for the answer which we consider show the greatest merit, and 5s. for the one we select as second best. In judging the repliess importance will be attached to clearness and conciseness, as well as accuracy. The, Editor reserves the right to make no award, or to accept only one reply, if, in his opinion, the answers received do not possess sufficient merit. Competitors desiring the return of their manuscripts, if unaccepted, should enclose stamped addressed envelope.*

Write on one side of the paper only, and if diagrams are sent, draw them on a separate sheet of paper attached to the manuscript. Competitors may adopt a "nom de plume," but, both in the case of questions and answers, the competitor's real name and address must be sent with the manuscript as a guarantee of good faith. No correspondence will be entered into with regard to successful replies. The Editor's decision is final.

Commencing with Question No. 101, *a Diploma of Merit will be awarded to the six competitors who w n the first or second prize the most times during the next twelve months.*

The words "Questions and Answers" or "Q" and "A" should be placed a 'he top left-hand corner of all letters intended for this column.

QUESTION NO. 173.

I am employed on railway signalling, and I do not understand the construction and principles of operation of the following :—

(1) Track relays, galvanometer type.
(2) Track relays, vane type.
(3) Detection relays, polarised vane type.
(4) Purpose of shading bands on latter.

I would appreciate the details of operation, etc. The tracks are single-phase, 25 to 33½ cycles.—"JACK ALLEN."

QUESTION NO. 174.

Can any reader inform me of the process by which accumulators are treated to enable them to be put on the market in what is known as "a dry and fully charged condition," i.e., only requiring to be filled with dilute acid and to be given a short freshening charge?—"C. R. HARDY."

(*Replies to Questions Nos.* 173 *and* 174 *must be received not later than January* 5, 1924.)

PROBLEMS IN TELEPHONY, SOLVED AND UNSOLVED.*

By PROFESSOR J. A. FLEMING, M.A., D.Sc., F.R.S.

(*Continued from page* 648.)

Assuming the energy to flow out equally over the surface of a hemisphere of 2.5 cm radius with centre on the lips, this amounts to a total energy emission of 125 ergs per second. If we assume the speaking to be kept up for 1 hour, the energy represented by such speech waves would only amount to 1/20 joule or 1/27 ft.-lb. of work. Even if we consider the wave amplitude to be increased 20 or 25 times, as might be the case in loud speaking or public lecturing, the total production of air-wave energy in the form of speech might only amount to 20 or 25 ft.-lb. in an hour. The total bodily energy expenditure, as roughly judged by the fatigue of speaking to a large audience for an hour, even apart from bodily movements, is probably much greater. This gives an indication that the human vocal organs, considered simply as

* Lecture delivered before the Institution of Electrical Engineers, to whom we are indebted for the illustrations.

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an energy-translating device for the production of speech-wave energy, may have small efficiency in the technical sense of the term.

IV.—The Nature of Speech Sounds, and the Operation of the Ear.

(6) The possible improvements in telephony are very closely dependent upon a knowledge of the nature of speech sounds and of the operation of the ear in appreciating them. A careful study of the problem of phonetics in its relation to telephony has been made during the past few years in the United States. The important matter, from the telephonic point of view, is the study of the frequency-ranges required to convey specific articulate sounds with adequate reproduction at the receiving end.

Broadly speaking, phoneticians divide the elements of speech sounds into five divisions: (1) Pure vowels; (2) combinational and transitional vowels (indicated by the letters w, y, long i, h and ou; (3) semi-vowels, l and r; (4) consonants, voiced, unvoiced, and nasalized; and (5) fricative consonants, voiced and unvoiced. A very rough distinction between the vowel and consonant sounds is that the former can be uttered continuously as long as one has breath, but the latter are more or less abrupt beginnings or endings of vocal sounds.

The elements of all spoken languages are syllables, which are composed of combinations of the vowel and consonant sounds. Words are built up of syllables. The telephonic conveyance of speech depends, therefore, upon the accuracy of reproduction of the syllabic sounds at the receiver. In order to test this reproduction, telephonic engineers, in connection with the American Telephone and Telegraph and Western Electric engineers, prepared large lists of syllabic sounds comprising from 8,000 to 9,000 speech sounds in all, arranged in groups of 50 or 100.

A large number of these syllables are spoken in succession clearly to a transmitter. A listener at the receiver writes down the syllable received according to a certain code-word associated with it. The percentage of sounds correctly heard and written down is called the *articulation* of the system.

An account of certain research work of the above kind has been described by Harvey Fletcher in a paper* on "The Nature of Speech, and its Interpretation."

In this research a high-quality telephonic circuit was employed, comprising a condenser transmitter, an artificial line including thermionic amplifiers, an attenuator for weakening the speech currents in a known ratio, wave filters (described presently) for passing currents only within certain ranges of frequency, and received by high-quality magneto receiving telephones. By this apparatus speech sounds could be transmitted without distortion, but with amplitudes increased or diminished in exactly known ratios. When the amplitude is changed in the ratio of 2.71828 to 1, this is called reduction by 1 *napier*, since the above numeric is the base of the Napierian system of logarithms. If it is reduced in the ratio of $(2.71828)n$ to 1, this is called reduction by n napiers.

(To be continued.)

* See *Journal of the Franklin Institute*, June, 1922.

ELECTRICAL ENGINEERING—FINAL GRADE.

Solutions to 1923 Examination Questions of the City and Guilds Institute.

By Edward Hughes, B.Sc. (Eng.), A.M.I.E.E.

(*Continued from page* 647.)

Q. 11.—A continuous-current supply system is working at a busbar voltage of 200. It is desired to measure the insulation resistance to earth of each side of the system without interrupting the supply. A voltmeter of 12,000 ohms resistance is connected between the positive busbar and earth when it reads 5 volts, and between the negative busbar and earth when it reads 3 volts. Calculate the insulation resistance of each side of the system.

A. 11.—Let r_1 and r_2 be the insulation resistance of the positive and negative sides respectively; then if the

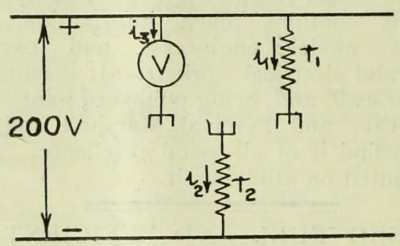


Fig. 16.

currents be as in figure when the voltmeter is connected on the positive side,

$$i_1+i_3=i_2.$$

But $i_1=\frac{5}{r_1}$; $i_3=\frac{5}{12{,}000}$, and $i_2=\frac{200-5}{r_2}=\frac{195}{r_2}$

$$\therefore \frac{5}{r_1}+\frac{5}{12{,}000}=\frac{195}{r_2} \quad \ldots\ldots(1)$$

Similarly when voltmeter is connected to negative side,

$$\frac{3}{r_2}+\frac{3}{12{,}000}=\frac{197}{r_1} \quad \ldots\ldots(2)$$

From (1), we have

$$\frac{5}{r_1}=\frac{195}{r_2}-\frac{5}{12{,}000}=\frac{2{,}340{,}000-5r_2}{12{,}000r_2}$$

$$\therefore r_1=\frac{12{,}000\times 5r_2}{2{,}340{,}000-5r_2}$$

and from (2), we have

$$\frac{197}{r_1}=\frac{36{,}000+3r_2}{12{,}000r_2}$$

$$\therefore r_1=\frac{12{,}000\times 197r_2}{36{,}000+3r_2}$$

Hence $\frac{12{,}000\times 5r_2}{2{,}340{,}000-5r_2}=\frac{12{,}000\times 197r_2}{36{,}000+3r_2}$

$$\therefore 180{,}000+15r_2=461\times 10^6-985r_2$$

$$\therefore 1{,}000r_2=10^6(461-0.18)$$

$$\therefore r_2=460{,}820 \text{ ohms}$$

and $r_1=\frac{12{,}000\times 197\times 460{,}820}{36{,}000+1{,}382{,}460}$

$$=768{,}000 \text{ ohms.}$$

i.e., insulation resistance on positive side = 0.46 megohm, and insulation resistance on negative side = 0.77 megohm.

(To be continued.)

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Various Items.

Political.—Two members of the National Union of Commercial Travellers have been elected to the House of Commons as a result of the General Election.

Beckenham.—The Beckenham electricity undertaking, which is municipally owned, has advanced to first place in its class in London for efficiency and the second in the kingdom.

Brighton and Hove.—It has been decided, as the result of experiments, to instal an improved system of electric lighting on a part of the sea-front. Triangular lights are also to be kept going throughout the night for the guidance of fishing boats.

Personal.—Sir Charles Bright, F.R.S.E., wishes it to be understood that he has withdrawn from the board of Sir Charles Bright and Partners, Ltd.——Sir Alexander Kennedy, F.R.S., has been invited to speak on "The Application of Electrical Energy" at the World Power Conference, which is due to be held in London in July next.

Wembley.—Norfolk Studios, Ltd., the advertising specialists, of Racquet Court, Fleet Street, E.C.4, are preparing a special scheme for exhibitors and non-exhibitors, and will be very pleased indeed to submit their suggestions to any firms who may be anxious to have a descriptive campaign in connection with this coming great undertaking.

Newport Electrical Exhibition.—The model electric house, which was one of the most attractive features of this exhibition, was exhibited by the Corporation, and the apparatus therein was installed throughout by the General Electric Co., Ltd., including the fittings, Osram lamps and the Magnet heaters and cookers. The company also had a prominent stand in the Exhibition, which was, we understand, very successful both from the educational and direct business points of view.

Business Expansion.—Congratulations to Bertram Day and Co., Ltd., complete advertising service agents, of 9/10, Charing Cross, S.W.1, who, for the second time within three years, have had to seek additional office accommodation, the continuous growth of their business having now necessitated the removal of their service department to No. 1, Charing Cross. Undoubtedly their success reflects the commercial progress of the many important manufacturing and trading firms for which this go-ahead agency are acting.

Northampton Polytechnic.—As usual, much interest was taken in the annual distribution of prizes and certificates on Friday, the 7th inst., and hearty congratulations are due to the principal, Dr. Mullineux Walmsley, on the progress shown by the Institution itself and by the men holding high positions in all parts of the world who have been trained by him. It is a splendid record. The conversazione on the Saturday was also remarkably well attended, and much appreciation was shown with the musical arrangements as well as with the other entertainments provided.

Good Lighting as an Aid to Safety.—The motto "Safety First" has already become a power in the land, and we are glad to see that it is being linked with the provision of good illumination. An illustrated booklet on the above subject, written by Mr. Leon Gaster, and in a revised and extended form, has just been issued by the British Industrial Safety First Association. The booklet contains many telling arguments in favour of good lighting, as well as explanations of what is meant by this term. Many illustrations, both of gas and electric lighting installations, are included. Needless to say, the booklet is written on quite impartial lines. But its circulation amongst manufacturers should prove of considerable benefit to firms concerned with electric lighting, besides being an undeniable public service.

Tenders Accepted.—Ozonair, Ltd., have just completed, or have in hand, installations of their system of pure-air ventilation for the following firms, viz.: Messrs. Liberty and Co., Ltd., new premises, Tudor House, Argyll Place, W.; Style and Mantle, Ltd., premises, Oxford Street, W.; C. and A. Modes, Ltd., premises, Oxford Street, W.; City of London Corporation, underground convenience; Chelsea Borough Council, underground convenience; Société Générale de Belgique, Brussels, bank premises; and the Bon Marché, Brussels, new premises.——The Vickers-Spearing Boiler Co., Ltd., of 20, Kingsway, W.C.2, were last week successful in securing a contract for the second section of extension of generating plant, consisting of four large water tube boilers of the Spearing type, for the Leicester Corporation Electricity Works.

Lloyd's Register Scholarships.—We have received from the Institute of Marine Engineers a circular giving full details of these scholarships, as well as of the student graduate examinations and essay competition. They are, of course, applicable more particularly to sea-going engineers, and we note that electrical engineering is one of the subjects for examination.

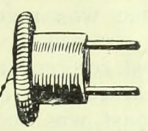
Production.—The next meeting of the Inst. of Production Engineers will be held at 7.30 p.m. on the 19th inst. at the Engineers' Club, when Mr. L. W. Wild, M.I.E.E., will read a paper on "Electric Furnaces," to be illustrated by lantern slides. All interested are invited to attend, whether members of the Institute or not, and no tickets are necessary. We recommend this most cordially to the notice of our readers.

Trade Notes.

Constructors, Ltd., 4, Brook Street, St. Paul's, Birmingham, have recently issued a catalogue of their Welconstruct slotted steel, which can be used for a very large number of purposes in connection with the electrical industry. In fact, the list shows it as used for switchgear frames, motor control panels, transformer chambers, colliery sub-station work, etc. The list should therefore be of direct interest to all electrical installation contractors, to whom it will willingly be sent on application.

Leaflet 251R, which has just been issued by **Henleys Telegraph Works, Ltd.**, illustrates and describes the new super box which has been introduced in connection with the well-known Henley Wiring System. The makers claim that this is the most efficient wiring system box produced, as it is easier to connect up and more certain in its application. The price is moderate, and the leaflet is most certainly one which should be in the possession of every wiring contractor in the kingdom, to whom it will be willingly sent on receipt of proper trade application.

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A H(E)ART-ILY ENJOYABLE EVENING.

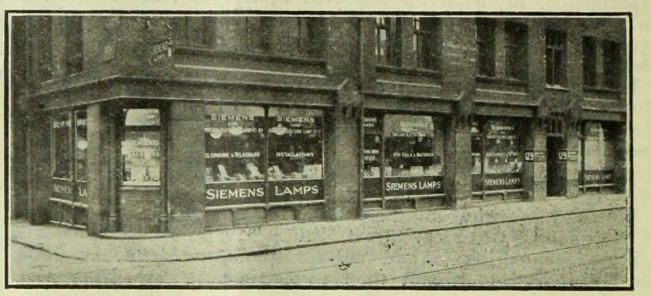
The Staff Dinner of the Hart Accumulator Company, which was held at Frascati's on the 6th inst., was one of those pleasant functions which do so much to foster harmonious working and improve the relationship between employers and their staff. Mr. Holmes, who presided, made an admirable chairman, and as an excellent dinner was followed by a first-class musical programme interspersed with brief but pithy speeches, everything went along with perfect smoothness and no one worried about the dense fog then filling the London streets. The toast of "The Hart Accumulator Company" was ably proposed by Mr. Rouard, who as a commercial man expressed the pleasure it gave him to push and sell a first-class article which is in regular use in such varied installations as from telephone plant to battle-ships or express trains to wireless. He aimed steadily at making their name world renowned in the same sense as Pears soap. The toast was coupled with the name of Mr. Holmes, the director and manager, who expressed cordial thanks for the way in which the toast had been proposed, and then told an amusing yarn about the office boy who told a lie and ultimately became a commercial traveller. At Mr. Holmes' suggestion it was arranged to send a letter of greeting to the duplicate company at St. John's, Quebec, expressing the best wishes of all present coupled with seasonable greetings. He referred with pleasure to the work of the staff and said how much of the company's success was due thereto, while the long life of their batteries was something to be proud of. Later in the evening Mr. Breeze, secretary of the company, proposed "The Guests" in a very kindly and hospitable manner, to which a suitable response was made by Mr. Rentell, and finally Mr. Holmes proposed the toast of "The Organising Committee," and referred to the hard way in which Mr. Duncan had worked to ensure its success. Needless to say, the toast was received with enthusiasm, and Mr. Duncan, who is in charge of the progress department, made a very humorous reply. Altogether a most enjoyable evening.

THE INSTITUTION OF AERONAUTICAL ENGINEERS.

We are in receipt of a ticket issued by the Institution of Engineers which will admit us and friends to a lecture by Mr. John Gray, B.Sc., M.I.E.E., entitled "Leader Cable Systems for the Electrical Steering of Aeroplanes," to be given at the Royal Society of Arts Hall, John Street, Adelphi, London, W.C.2, on Friday evening, December 14, 1923, at 7.30 p.m. The paper was written by William Loth, of Paris, and it is expected that the lecture will be of outstanding interest, as to the best of our knowledge the system has not previously been published in this country. Since this subject will greatly interest many of our readers, Mr. Howard Flanders, the secretary of the Institution, informs us that any reader may have a ticket which will admit him and his friends if they will make application to him at 60, Chancery Lane, W.C.2. Since the time between the publication of ELECTRICITY and the time the lecture is to be delivered is so short, it is possible that a large number of our readers may not have the opportunity of applying for tickets in time to hear the lecture. We have, therefore, arranged for an abstract to be published next week.

SIEMENS AT LEEDS.

Owing to the renumbering of Park Lane, Leeds, by the postal authorities, the branch address of the Siemens and English Electric Lamp Co., Ltd., has been altered from 85-91 to 129, Park Lane. As shown in the annexed illustration, the premises occupied by the company are on the ground floor and comprise a large,

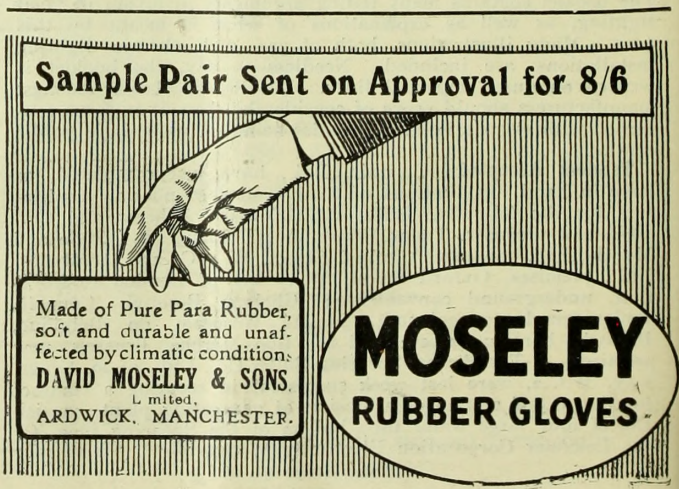


well-appointed showroom and stores, in which large stocks are held of all types of electric lamps, fittings, accessories, fuse material and domestic appliances, etc. All these goods are effectively displayed and may be seen to great advantage in the spacious showroom, which is well worth a visit.

Calendars.—We have received from Messrs. Bruce Peebles and Co., Ltd., of Edinburgh, a set of renewal date cards for the handsome metallic calendar to which we made reference in the early part of this year.

Comfort.—Two very nice illustrated electros showing the advantages of electricity have just been issued by E.D.A. One represents "Twenty Minutes' Comfort for One Farthing," and the other "Daddy tells a Christmas Ghost Story," and we can recommend them to all electrical contractors and factors as being just the right kind of illustrations to use at the present festive season, in order to push the sale of electrical appliances.

London's Great White Way.—Evidently the borough of St. Marylebone is doing its best to claim this distinction for the eight miles of streets in which the white Osram lamp is being adopted for lighting purposes. The borough has had a reputation for enterprise for some long time, and on Monday, the 3rd inst., they started the campaign by switching on over 1,400 of these well-known lamps (1,100 of 150 watts and 300 of 100 watts) in such well-known thoroughfares as Maida Vale, Edgware Road, Chapel Street and Great Portland Street. A most important point in connection with this progressive act is that as the lamps provide light without glare they will materially minimise the risk of accidents to drivers of fast-moving vehicles.



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A POPULAR SCIENTIFIC WEEKLY JOURNAL
ELECTRICITY
A PRACTICAL TRADE JOURNAL

DECEMBER 21, 1923.

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MR. BOUNCER MEETS MR. STAN DARD.

By George E. Moore.

The Ineffable Mr. Bouncer.

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This year's exodus from the university had included Mr. Bouncer, and the old quad., the labs., the amiable "Prof.," the latter's vivacious typist, and the pastry-cook across the road, were to know him no more. There remained one steadfast, though dumb, witness of the young gentleman's passage—the panel of his desk in the lecture theatre. One day the nervous demonstrator had dropped his pencil, then for some reason trodden on it, and finally sat down rather suddenly on the platform in some confusion and a considerable cloud of dust. Mr. Bouncer took a prominent part in the applause which followed, and his footwork during the delicate exhibition of humour was so vigorous that a panel in his desk was shattered. Thus the new panel to be seen there is a sort of monument, and indeed, if you look closely, you will see Mr. Bouncer's initials (with the momentous date) engraved thereon—third row up, fourth place from left.

Mr. Bouncer's entry into the workaday world was quiet and unheralded. He more or less expected this. Later on, in perhaps a year or so when he had made his mark, the happening would attain some significance, even notoriety. He was tremendously in earnest (put this down to his credit), but he was also entirely in the dark as to the conditions of the practical world he was entering (his training in this respect had left him a vague optimist). One might almost say that he had been so thoroughly educated as to be of no immediate use at all. As I say, he was in earnest, and he was perfectly confident, but his confidence was the confidence of ignorance. He was like the newcomer to the front line during the war: foolishly venturesome when his mate, no less brave but more experienced, dived for cover.

The magic letters "B.Sc." were, to Mr. Bouncer, his "Open Sesame!" He believed they would carry him anywhere. In the dream world which his imagination pictured, they represented a good position with a four-figure salary in the near future. He was yet to learn that big (and even little) salaries are paid for *tackling* jobs. Inevitably, and without being aware of it, he was an academic snob. The world of electrical engineering of his imagination was a nice, clean, spick-and-span place, where everything went on quietly and smoothly, and where you leisurely moved with that certainty, efficiency and status derived from a formidable alliance of brains and books.

It needed but a short acquaintance with the real world, and lo! Mr. Bouncer's conceptions began to be severely stressed. He was horrified to find that electrical work partook of the nature of general industrial conditions. That dream world which he had pictured was not there ready-made. He would in time realise that the little job of his own career and the big job of the world's progress possessed many humbling and formidable things in common. And he had been so dogmatic and idealistic in the debating society—one of the shining lights, in fact. How that light flickered in the cold blasts of the outer world!

His encounter with Mr. Stan Dard was one of the jolts which formed part (did he but know it) of his continued education at a centre of learning to which he repaired on leaving the university. This place bore the strange name of

"The Rest House."

This was *not* an official name. It was a name bestowed by outsiders upon an edifice whose door bore the arresting word "TEST," and officially referred to as "The Test House." According to the said outsiders, whenever you looked into the test house you would see plenty of people gazing into vacancy or even meters, or having confabs, but apparently never working. Hence "Rest House." The test chief was unaware of the insult. Every morning he would be seen arriving at 9.30 and pausing awhile to gaze with great satisfaction at the word on the door. The pause was much appreciated by the rest-house staff.

The rest house was situated a little way from the power station of the undertaking, a devious clinker path leading up to it. The rest-house staff would explain that the power station was an incidental sort of place a little way from the test house, and you got the idea that if the power station blew up, the undertaking (thanks to the test house) would continue to function quite well. The interior of the rest house was one large room, and it was divided by invisible but very definite lines into sections, each section having a "pill-box" for its commanding officer. Whenever there was a state of internal tension the C.O. of, say, the metering section, might be seen exchanging warlike glances over no-man's-land with the occupant of the steam pill-box.

This was the place which received Mr. Bouncer as junior general assistant, but before disclosing his disturbing experience permit a digression to introduce a gentleman sharing the honours:

Mr. Stan Dard
(of the Rest House Instrumental Section).

Mr. Dard was of an arresting type. He wore his clothes tarpaulin fashion, and he sported a black velour hat of great antiquity; the clothes were part and parcel of the man and, apparently, never removed, but the black velour hat was subjected to a daily series of sur-

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prising adventures which included being thrown violently away in moments of excitement, and worn wrong way round at times of intense mental stress. Nobody was ever sure of Mr. Dard—he was so surprising and uncertain. One of his assistants, with a doleful smile, would affirm that he was "harmless as a lion." Not a soul knew anything of his outside life; he was only *presumed* to have some sort of existence after knocking-off time. He simply appeared in the morning and vanished in the afternoon.

Quite a little drama would be enacted every morning. At nine o'clock Mr. Dard's assistants would begin to stir uneasily, and when the great man bustled in there would be a sudden air of activity, and a couple of polite "Good mornings." A lot depended upon the reception given by Mr. Dard to these. When Mr. Dard had entered his pill-box and a diplomatic interval had elapsed, there would be a reconnaissance by the assistants, and Mr. Dard's appearance and the disposition of the black velour hat duly noted. Then the senior assistant, who privately considered that for so critical and pushing a beggar the junior was strangely backward for once, would slowly approach the sanctum and, with an ingratiating smile and a sinking heart, enter to learn his fate.

If there happened to be a big job on hand, Mr. Stan Dard never failed to rise to the occasion—never! A big job always had two cycles: one of bustle and one of peace. In the first cycle there would be the clacking of switches; the whine of the generators; the feverish tapping of instruments by the assistants; a multitude of papers and fierce orders flying about; and here, there and everywhere the irrepressible Mr. Dard. Then would come as a blessed relief the cycle of peace, during which Mr. Dard, having retired to his pill-box, would be busily digesting the data. Now and again the black velour hat would be seen mounting to the ceiling, and during its descent Mr. Dard would yell either "Good" or "Bad" to his assistants. They, for their part, had adopted a detached air at the close of the first cycle, and would speculate in undertones as to the "for and why" of the job, for "old Standy" (like a wise general) always kept his army in the dark regarding his plans.

When the yell of "Good" would come from the pill-box the assistants would brighten up astonishingly, and the senior would put his hands in his trouser pockets and relax (but keep a wary eye open, all the same). But if the yell should be that of "Bad"—my word, what a change! The junior would suddenly hear from his gloomy senior that he'd better look alive, and sharp—if he just took the trouble to open his optics (he didn't *mind*, did he?) there was many a little thing he might be doing instead of hanging around yawning his blinking head off. So would pass the second cycle. It suddenly finished with the dramatic reappearance of Mr. Dard when least expected—he might drop through the skylight or pop up from beneath the bench, *they* could never tell—and in a minute, away they all were in the thick of it again. Woe betide them if Mr. Dard was in form! He would have so many re-checks that they would miserably sigh for the carefree and romantic life of a shift engineer.

Thus Mr. Stan Dard of the Rest House Instrumental Section, and the disturbing environment in which he moved and had his being.

(To be continued.)

BRITISH EMPIRE EXHIBITION POWER SUPPLY.

The present demand for electrical power for motive and lighting purposes at the British Empire Exhibition is approximately 10,000 kw., including 1,350 kw. for the Amusements Park and 750 kw. for the Never-Stop Railway. This demand will be met from three sources: (*a*) an A.C. turbo-alternator power station adjoining the Palace of Engineering, (*b*) an A.C. substation supplied by the North Metropolitan Supply Co., (*c*) a D.C. supply from reciprocating plant in the Palace of Engineering, and from rotary converters.

The power station will generate 3,000 volts, 3-phase, 50 cycles, and a general supply will be given at 415/240 volts, 3-phase, 4-wire. The supply from the North Metropolitan Co. will be at 11,000 volts, 3-phase, which pressure will be stepped down by 4-500 k.v.a. transformers to 415/240 volts. The North Metropolitan Co. substation will be interconnected with the power station busbars by an 11,000 volt armoured cable, and a 1,000 k.v.a. 11,000/3,000 volt transformer. The D.C. supply will be at 220/440 volts from a number of reciprocating sets, and from 3-500 kw. rotary converters fed from the 3,000 volt supply. A direct 3-phase supply at 3,000 volts will be available for a limited number of exhibitors showing and operating large power plants.

The supply to the Stadium will be from an independent substation, fed from the network of the North Metropolitan Supply Co.

The lighting of the Exhibition grounds will be by 560 standard lamps, each equipped with a 600-watt gasfilled lamp. The exterior of the main buildings will be illuminated by floodlighting.

The steam-raising plant comprises two land type water-tube boilers by Messrs. Babcock and Wilcox, and two water-tube boilers by the John Thomson Water-Tube Boiler, Ltd., all having a normal evaporation of 20,000 lb. per hour, at a pressure of 220 lb. per sq. in. Each boiler will be equipped with integral superheater and a complete economiser. Each battery of boilers will be arranged for induced draught working, and will discharge into a self-supporting steel chimney 6 ft. in diameter by 75 ft. high. Two feed pumps will be provided, the one steam driven, the other of the 4-stage centrifugal type, electrically driven, each pump being capable of delivering 10,000 gallons per hour. Two water softeners will be installed, each of a capacity of 1,000 gallons per hour, for treating water from the Colne Valley Co.'s supply.

The coal and ash handling plant includes electrically operated wagon tippler arranged to receive fully loaded wagons from the siding and discharging these into a coal store. From the store the coal is conveyed to a patent automatic skip-hoist arranged to elevate the coal to bunker level, whence it is conveyed into any desired bunker. Embodied in the main conveyor is a continuous automatic weighing machine. The ash handling plant is of the water sealed type, arranged to convey the ashes from tanks under the boiler to an ash bunker outside the power-station building.

The generating plant in the power station comprises three 1,500 kw., 3,000 r.p.m. turbo-alternators, for 3,300 volts, 50 cycles, 3-phase supply, these sets being supplied respectively by B.T.-H. and Cole, Marchant and Morley; James Howden, General Electric Co.,

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John Musgrave; and English Electric Co. The main H.T. switchgear is by Reyrolle and Co., of the compound filled remote controlled type. A Tirrill regulator will be installed, and arranged to operate on any one of the three alternators. The neutral point of either machine can be earthed through a single-phase remote controlled oil switch by an Everett Edgcumbe carbon powder type earthing resistance. The control battery is of 60 cells, each of 150 amp. hours' output, and will supply emergency lighting as well as operate the Reyrolle switchgear. An A.C. to D.C. motor generator will be installed for charging the control battery.

The power-station substation contains the 3,000/11,000 interconnecting transformer already referred to, the 11,000 volt switchgear of which is by the General Electric Co., with McColl balanced current protective gear. The four transformers for the local low tension A.C. supply are respectively by the B.T.-H. Co., Brush Electrical Engineering, Ferranti, Ltd., and Johnson and Phillips, and are each of 500 k.v.a. output. The low tension A.C. switchboard is of the protected iron-clad type by Allen, West and Co. The A.C. local supply is given by two 500 kw. rotary converters; one, by the B.T.-H. Co., being of the self-synchronising type; the other, by the English Electric Co., being arranged for tap starting. The D.C. switchboard is by the Park Royal Engineering Co.

No. 1 substation receives a low-tension A.C. from the adjoining substation of the North Metropolitan Supply Co., which supply is distributed to local circuits by a low-tension switchboard supplied by George Ellison and Co.

No. 2 substation contains four 500 k.v.o., 3,000/415 volt transformers, respectively supplied by the B.E.T. Co., Brush Co., Ferranti, Ltd., and Johnson and Phillips. The H.T. supply to these transformers will be from the power-station busbars, and will be controlled by a B.T.-H. manually operated, totally enclosed, truck-type, compound-filled E.H.T. switchboard. The L.T. output from the transformers is controlled by a switchboard, also of B.T.-H. manufacture. Four low-tension feeders are so arranged that they can be changed over to the North Metropolitan Co.'s supply, These feeders are controlled by a special switchboard by the General Electric Co.

No. 3 substation is equipped with two 500 k.v.a. transformers, by the Brush Co., and Johnson and Phillips. The L.T. and A.C. switchboards in this substation are both by the General Electric Co, the transformers being equipped with the McColl system of protection.

A special colour lighting substation will be supplied by three 250 kw. 3-phase L.T. feeders from No. 2 substation, each feeder being connected to three single-phase liquid dimmers, the colour-lighting circuits being supplied from these dimmers.

A complete duct-system has been installed to accommodate the numerous H.T. and L.T. cables required to distribute the supplies. The H.T. cables are of the paper-insulated, lead-covered and wire-armoured type. The A.C. L.T. cables are of the 4-wire paper-insulated and lead-covered type. The L.T. A.C. network will be controlled by some 50 to 60 distribution pillars of standard type

The cables in the Amusements Park will be laid direct in the ground, 4-core cables being used for the low-tension A.C. supply, the D.C. supply being given by single core, paper-insulated, and lead-covered cables.

Finally, it may be noted that, although the power station is of relatively small capacity, the equipment, both as regards labour-saving devices, and methods of control, will exhibit in all details the most modern and up-to-date practice.

GECOPHONE MODEL "B" 2-VALVE RECEIVING SET.

A 2-valve panel set, known as model "B," has been developed recently by the G.E.C. The first valve is a high-frequency amplifier, the second a detector; aerial tuning is by variometer, while the anode circuit is tuned by variable condenser. It is designed for wave-lengths between 300 and 500 metres, but provision is made on the panel for the addition of a loading coil and interchangeable reactance coil to cover other wave-lengths. The component parts are similar to those used in the more expensive Gecophone 2-valve cabinet set, the normal range being 100 miles.

"ELECTRICAL AIDS FOR THE DEAF."

At the meeting of the Informal Section of the I.E.E. on Monday, December 3, Mr. J. Coxon was in the chair, when Mr. C. M. R. Balbi opened a discussion on "Electrical Aids for the Deaf."

The large gathering on this occasion contained a number of visitors from the Royal Society of Medicine, several of whom spoke and provided the practitioner's experiences to complete the points of view.

Mr. Balbi defined deafness as sub-normal hearing, and said it was of two natures—deafness of the outer ear which could be cured or aided in 90 per cent. of cases, and deafness of the inner ear which is beyond all known aids. He had lantern slides showing the structure of the ear, with its series of diaphragms and connections, and he described the physiology of the audition processes, the sound waves and the degrees and defects of atrophy, loose contacts, and dirt. He exhibited a few pieces of apparatus designed to aid the deaf, and explained the need for providing indications of the direction of sounds.

Dr. J. A. Fleming, F.R.S., said he was in the unfortunate position of being able to speak from first-hand experience of deafness. It was not sufficiently recognised that instruments have to be devised for the particular types of deafness; further, they must be readily portable and as inconspicuous as possible. Apparatus for hearing sounds at a distance are not usually adapted for conversation, and he advocated that public buildings, theatres and churches should have seats wired from a transmitter at the platform or pulpit, so that the deaf might plug in and be enabled to hear.

Dr. William Hill (St. Mary's Hospital) said many of the electrical aids produced by his patients were very unsuitable, and he had often found a broad collector of sound like a trumpet was more effective and, of course, much less expensive.

Mr. J. E. Kingsbury and other speakers said that people shrank from displaying their disability by the use of a speaking trumpet.

Dr. Sidney Scott said some years ago he endeavoured to get Prof. Sir J. J. Thomson to enlist a senior wrangler to investigate the profound mathematical problems of autology, so much is yet to be explained.

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He knew of cases where the tympanic membranes are fractured, and the patients are not deaf—cases where the patients can hear although by present reasoning should be suffering from deafness.

Dr. F. Thompson described his experiments with wireless apparatus on congenital deaf and dumb subjects. They successfully reproduced sounds they had been enabled to hear.

Mr. L. V. Rein, who had just returned from America, said that the New York League for the Hard of Hearing actually had a hall equipped with wiring in the manner suggested by Dr. Fleming.

Mr. J. W. Wheeler pointed out that the authorities are spending large sums on the special education of sub-normal children; while this discussion had indicated that many of them must be within easy aid of modern apparatus at very considerably less expenditure.

Messrs. M. D. Hart, F. S. Robertson, P. G. Pettifor, A. A. Williams, W. Day and J. Coxon also spoke, and Mr. Balbi replied to the questions raised.

INTERNATIONAL ELECTROTECHNICAL COMMISSION.

It having been found impossible to hold a plenary meeting of the I.E.C. in Rome this year, as had been proposed, a meeting of the Council was held in Paris on December 3, when delegates from ten of the National Committees were present. Dr. C. O. Mailloux, the president, who came from New York, Colonel R. E. Crompton, C.B., the honorary secretary, and Mr. C. le Maistre, C.B.E., the general secretary, were also present.

Signor Guido Semenza, of Milan, was elected president of the Commission, and Dr. Mailloux, the retiring president, to whom the Commission owes so deep a debt of gratitude, was elected honorary president.

The Council appointed a committee to assist in giving effect to the decisions, to co-operate with the central office in carrying out its objects, and to co-ordinate the work of the National Committees as well as of the Advisory Committees. This committee will meet once or twice a year, and it is hoped thereby to accelerate the work of the Commission.

The Council also authorised the central office, in consultation with the president and past-president, to take the necessary steps towards the calling of a completely International Conference on Terms and Symbols for Radio Communication.

THE SOCIETY OF ENGINEERS.

The following premiums have been awarded for papers read before or published by the Society during 1923:—

President's Gold Medal: Mr. J. W. Gordon, K.C. "Railway Surveying by Photography."—Bessemer Premium: Mr. P. Mauclere (value £5 5s.). "The Pneumatic Handling of Petrol and Other Inflammable Liquids."—Nursery Premium: Mr. A. Hiley (£3 3s.). "The Impact of Imperfectly Elastic Bodies, with particular reference to the effect of the hammer blow in pile driving."—Bernays Premium: Mr. A. Ferguson (£3 3s.). "A New Entirely Automatic Machine for the Mass Production of Glass Bottles."—Society Premium: Mr. A. S. E. Ackermann (£3 3s.). "The Physical Properties of Clay (fifth paper) and the Dynamics of Pile Driving."—Clarke Premium: Mr. R. C. Hill (£5 5s.). "Work Beneath the Waves" (read before the Gloucestershire Eng. Society, associated with the Society of Engineers).—Green Premium: Mr. H. F. Jones (£5 5s.). "Boilers" (read before the Crystal Palace Eng. Society, associated with the Society of Engineers).

A "C.T.S." COMPETITION.

The St. Helens Cable and Rubber Co., Ltd., of Slough, who hold a world-wide reputation as the inventors of the famous C.T.S. (Cab Tyre Sheathed) Wiring System, have arranged with the proprietors of ELECTRICITY to offer a duplicate series of prizes for the three articles sent in by competitors in (*a*) the United Kingdom and (*b*) the British Colonies, which, in the opinion of the competition judge, or judges, most clearly and practically explain the advantages and disadvantages of the C.T.S. system for wiring and other purposes. The terms of the competition are as follows:—

1. The length of the article not to exceed about 1,000 words, or, say, two columns of ELECTRICITY, and to be written on one side of the paper only. Clearness of wording should be aimed at, and unnecessary flattery will be deemed a drawback.
2. Diagrams are not essential, and, if used at all, should be as few as possible, owing to the space limit.
3. There are no special restrictions as to competitors. The desire is to appeal to as wide a circle as possible, and for that reason the prizes will be in duplicate in order to enable colonial competitors to have an equal opportunity of expressing their views.
4. The papers sent in will be judged by Mr. W. E. Highfield, M.I.E.E., President N.A.S.E., and a member of the I.E.E. board of examiners, and no appeal can be made against the decisions arrived at.
5. The prizes offered are:—

First prize	... ...	Five Guineas.
Second prize	... ...	Three Guineas.
Third prize	... ...	Two Guineas.

   and the St. Helens Company would at their discretion award consolation prizes up to one guinea each where they consider it suitable.
6. It is part of the contract that all competition papers, including the actual prize-winning papers, become the property of the St. Helens Cable and Rubber Co., Ltd., and no application for their return can be considered.
7. Competition papers must be addressed to

   "C.T.S." Competition,
   ELECTRICITY Office,
   36, Maiden Lane,
   London, W.C.2,

   and those from the U.K. must be delivered not later than the last post on January 7, 1924. while those from the Colonies must be delivered by March 31, 1924.

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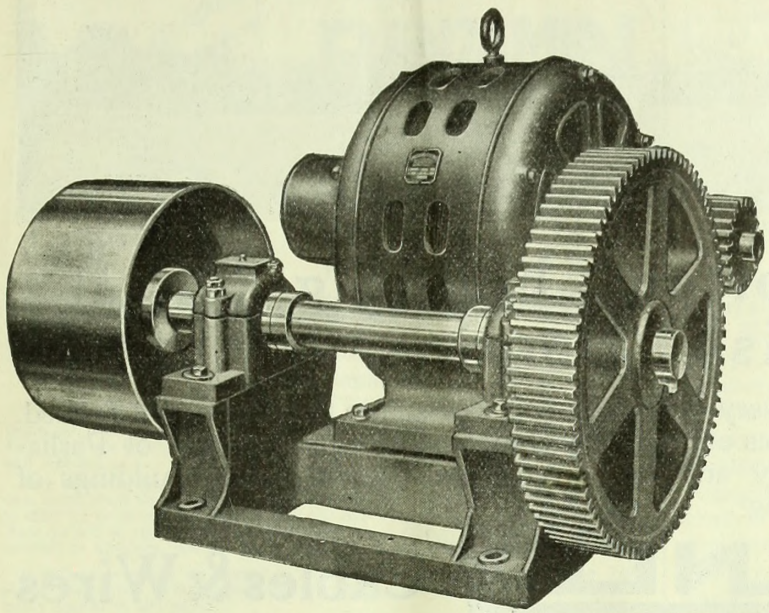


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Another stage

¶ No matter how different the conditions, most journeys, as they were of old, are still divided into stages.

¶ December marks the completion of another in the journey we are all taking.

¶ As we approach the end of any stage there comes a period of reflection.

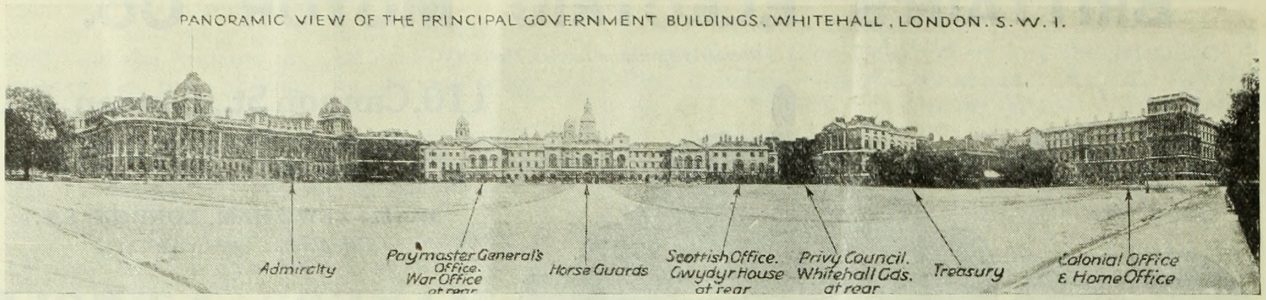
¶ It comes to us to-day and, looking back, it is apparent that our thanks and appreciation are due to all our fellow passengers—especially to our customers and friends.

¶ We tender them in all sincerity together with our heartiest wishes for THE festival of all the year and a brighter and better '24.

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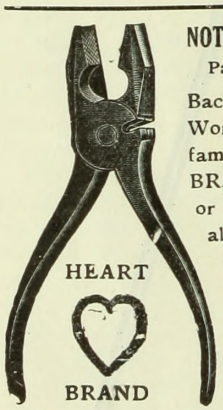
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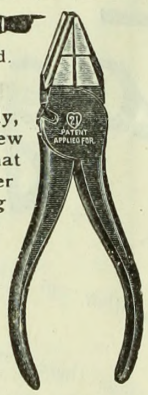


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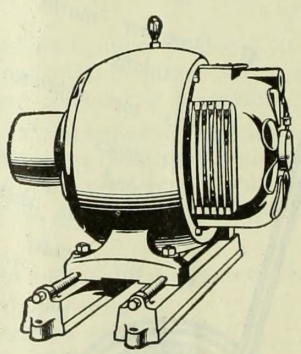
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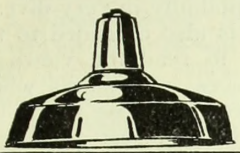


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TO OUR READERS.

ELECTRICITY is published every Friday, and, if ordered, is on sale at the principal Railway Station Bookstalls and Newsagents on that day. It has a very large sale throughout the United Kingdom, as well as in the British Colonies and Abroad.

New advertisements for the displayed columns and alterations to existing ones must reach the publishing office not later than first post Tuesday morning, in order to be in time for the issue of the following Friday. This is important. Rate quoted on application. Subscription : 13s. a year, 6s. 6d. half-year, 3s. 3d. a quarter in advance, postage prepaid in the United Kingdom and abroad.

Questions to which an answer is required must be accompanied by a 1½d. stamp for reply. When considered of sufficient interest, the answer will probably appear in the paper.

All remittances payable to the Publishers, S. RENTELL AND CO., LTD., 36–39, Maiden Lane, London W.C. 2. Telephone No. 2460 Gerrard.

Current Topics.

The Aftermath.

Now that the General Election is over and done with, it is interesting to reflect upon the influence of our industry upon the net results. In this connection a non-political body, the British Engineers' Association, canvassed its members, as well as a representative list of non-member firms engaged in the engineering and allied industries, including iron and steel manufacture, shipbuilding, marine engineering, mechanical, electrical and general engineering, on their attitude towards Mr. Baldwin's policy of Protection. Actually the question put to the various representative firms in these industries was : "Are you in favour of the Prime Minister's policy of protecting our manufacturing industries in the home market?" Over 1,000 replies were received from firms representing, no doubt, in the aggregate, several millions of employees, and the analysis was as follows : Yes, 81.8 per cent. ; No, 15.4 per cent. ; indefinite, 2.7 per cent. In the circumstances it is fairly evident that influential engineering opinion did *not* turn the scale against a protective tariff, and our industry can therefore be credited with sufficient intelligence to appreciate the value of a policy which has been adopted by every other nation save our own.

"Irish."

A typically Irish controversy emerges from a recent meeting of the Dalkey Urban District Council which, holding that the overhead electric cables in the town were dangerous, decided to request the Tramways Company to have them placed underground. A member remarked that they would be even more dangerous underground, as, if a workman happened to stick a pickaxe in a cable, he might be killed. Some more enlightened member of that same council lost a splendid opportunity of countering with the suggestion that wireless power transmission be adopted as an alternative. Truly, there is no satisfying Paddy, and the best thing is to leave him to his ancient rushlights ; even these might set the house afire and roast his pork before it was killed.

"Candles Limited."

Apropos of rushlights or their more modern equivalents, candles, it is fairly evident that this early and convenient form of illuminant is by no means dead. It is stated that the capital of Candles, Limited, has been increased from £50,000 to £8,500,000. The company is a combination of the interests of Lever Bros. and oil companies, including the Shell Company and the Asiatic Petroleum Company, and was formed to develop the candle-making industry on a large scale. The oil companies are large producers of paraffin wax, which is the principal raw material of candles. Incidentally, the company is marketing a new type of candle ; it is moulded into a triangular shape with fluted sides, and it is claimed that it gives a 10 per cent. better illumination than the familiar round candle of commerce. Although modern candles are a marked improvement on their earlier prototypes, there is a good deal of truth in the suggestion that candle-makers reap a richer harvest from the wasted wax than from that which is actually consumed. The perfect candle and candlestick have yet to be invented. There is no truth in the rumour that this flotation is a direct result of the recent numerous electricity supply breakdowns in various quarters.

Cleanliness First.

Congratulations to the London Underground Electric Railways upon the enviable record they have created for clean and hygienic rolling-stock and stations, a condition which constitutes a standing example to most other transport concerns. According to statistics recently compiled, the Underground Railways bill for maintaining trains, stations, omnibuses and tramcars reasonably clean amounts to a quarter of a million per annum, or some £5,000 per week. According to a contemporary, if appearances are any guide, this amount is more than some of the trunk line railway companies spend in twelve months. Against this apparently heavy expenditure on the score of cleanliness, it must be remembered that the London combine system carries an average of 6,200,000 passengers per diem, and employs 2,000 cleaners, whose duty it is to cleanse 5,000 vehicles nightly.

In carrying out this task five tons of metal polish per year are consumed. The omnibuses are sprayed and disinfected at the end of each day, whilst the railway coaches receive similar treatment. The air of the tubes is maintained in a constantly healthy state by pumping 500,000,000 cubic feet of ozonised purified air into the stations and tunnels every twenty-four hours. My contemporary, the *Financial News*, aptly suggests that the company revise its well-known couplet, so as to make it read :—

> "Underground to everywhere,
> Germ-free cars and filtered air."

The many other railway and tramway authorities throughout the country might well take this lesson to

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heart and spend a little more on the cleansing and purifying of its vehicles and public premises. A good many cases of infection are directly traceable to railway, tram and omnibus travelling, and, if it could be quantitatively demonstrated, the unhealthy travelling conditions endured by a large section of the population of these isles is probably responsible for much of the illness and suffering among all classes, particularly during the winter months, when pulmonary complaints are rife. Cleanliness first is equally as vital to our well-being as safety first, and prevention is invariably better than cure.

Pavement Illumination?

A correspondent, who disclaims any electrical or illuminating qualifications, writes to a contemporary suggesting the inauguration of shielded kerb lighting for side walks and pavements in cities and towns. Although treated with derision by the contemporary in question, there is something in the suggestion which might commend it to the attention of the recently formed Association of Public Lighting Engineers and Superintendents. After all, what is wanted on the pavements and footpaths during the hours of darkness is good even illumination marking the limits of the space available for pedestrians, and incidentally the condition of the surface. In many towns and cities the present system of intermittent lamp standards, spaced at more or less irregular distances apart, is anomalous, inasmuch as 90 per cent. of the light is wasted in seeking to feebly illuminate the immediate surroundings of each standard.

I know of several towns where, due to hopelessly inefficient methods of street lighting (so-called), coupled with the worn or deranged condition of the surfaces which the unfortunate pedestrian is called upon to negotiate, it is positively dangerous to life and limb to perambulate certain thoroughfares after nightfall. Due to the uncertain light, the position of the actual kerb is indefinite, and the shadows cast by surrounding objects often give a false impression of solidity where, in fact, the path falls abruptly to the gutter, and an inadvertent step too far may entail a sprained or twisted ankle or even a broken limb. Moderate illumination of the actual surfaces of the pavements on either side of the principal and suburban streets could be secured at quite moderate cost by a carefully considered system of shielded kerbside lights, invisible to the eye of the pedestrian.

Such lights could be conveniently housed in substantial protecting hollow kerbs, spaced at suitable intervals and backed by the necessary internal reflectors. The scheme would effect considerable economies in the length of the conductor necessary to serve the lamps in a given street, whilst such a system would also save the not inconsiderable cost of cast-iron standards with their accompanying painting and maintenance. In thoroughfares already well served by existing shop-lighting at all times after sunset, such a system would be unnecessary, but in suburban areas, more particularly where existing gas and even out-of-date electric lighting is hopelessly inadequate, it might well be introduced with assured success.

I am delighted to hear that quite a large number of my readers are taking a keen interest in the C.T.S. competition, which was announced in last week's issue, and is again repeated in the current issue. It is well worth entering into, and I hope that the result will be an essay setting forth clearly the points for and against a system of wiring which has, at any rate, proved its adaptability in very diverse directions. As the competition is also extended to the Colonies it will be interesting to read the views of those who write their experiences in climates which are, in many cases, totally different to those prevailing in this country, and they may be of direct advantage to the industry in general, as well as to the C.T.S. makers in particular.

The C.T.S. Competition.

The choice of Mr. W. E. Highfield as judge is a very happy one. His position and opinion carry weight in the profession, as he is the president of the National Association of Supervising Electricians, and on the Board of Examiners of the Institution of Electrical Engineers, so he is eminently qualified to sit in judgment on the articles which may be contributed by the competitors. And, after all, five guineas is a very respectable fee for an article of about a thousand words, particularly in these hard times. My advice, therefore, to my readers is to go in and do their hardest to win one of the prizes. Someone has to get them, "of that there is no shadow of doubt, no possible, probable shadow of doubt, no possible doubt whatever."

The Lighting of Factories.

The general interest in the lighting of factories was illustrated by the informal discussion on this subject introduced by Mr. W. P. F. Fanghaenel and Mr. W. N. Booth at the Institution of Civil Engineers on December 12, following the meeting of the Illuminating Engineering Society on the previous evening, when the matter was also considered. The authors, who dealt with their subject in an interesting manner, were respectively concerned with electric and gas lighting, and there was some amusing interchange of views on the merits of the two illuminants. The much debated question of standards of illumination came up for consideration. Mr. L. Gaster, who joined in the discussion, "cleared the air" by explaining the attitude of the Home Office Departmental Committee and pointing out the fundamental difference between recommended practice and legal minima.

ELEKTRON.

MUNICIPAL ELECTRICAL OLD STAGERS.

The Committee of the Municipal Electrical Old Stagers have met recently and it has been arranged to hold another dinner, at the Hotel Cecil, on January 17, at 7 o'clock for 7.30 p.m. As before, there will be only one toast, in addition to the loyal ones, one speaker proposing and two responding. At the close of the speeches the party will adjourn to another room to talk over old times and to inspect objects of interest lent by Old Stagers.

It is proposed to invite Mr. S. E. Britton, president of the I.M.E.A.; Mr. H. Booth and Sir Harry Haward (the only two Commissioners not eligible to attend as Old Stagers); Mr. W. L. Madgen, first honorary secretary of the I.M.E.A.; Dr. S. Z. de Ferranti;

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and Mr. Spencer Hawes, who has been identified with the tables in the *Electrical Times* since they were started; but in order to retain the distinctive character of the gathering, namely, the meeting together of old friends, all of whom practically know each other, no other private or official guests are invited.

Tickets, price 25s. each, inclusive of wines, can be obtained of the Hon. Sec., Mr. C. H. Wordingham, at 7, Victoria Street, S.W.1.

Articles of historical interest, including examples of early apparatus, relics of faults, photographs of early stations, etc., which Old Stagers are willing to lend for the evening, will be greatly appreciated. Those who are disposed to help forward the success of the evening in this way are requested to send Mr. Wordingham particulars of what they propose to lend, and arrangements will then be made for their reception. Anything bulky or heavy would not be suitable.

LEADER CABLE SYSTEMS FOR ELECTRICAL STEERING OF AEROPLANES.*

By Mr. John Gray, B.Sc., M.I.E.E.

The object of this lecture is to bring to the attention of this Institution a subject which, although known to some of your members, does not appear to have attracted the attention that its importance warrants.

Fundamentally an old idea is used, namely, that of guiding the ship by means of suitable apparatus on board, whereby the electric current in a cable laid, for example, in a harbour can be detected so that the ship may be safely steered into the harbour.

So far as the author is aware, no attempts, other than his own, have been made to apply this method for the purpose of steering aircraft. The author has given the subject his attention over a period of ten years. He has studied experimentally and mathematically the shape of the magnetic field of the loop comprising the insulated conductor, and the earth or water return, the insulated part of the loop being fed with a high-frequency alternating current. He has made thousands of measurements for determining the shapes of the magnetic fields, and he has found as a result of his experiments, which in the air have been carried out at distances as great as 15 kilometres from the cable, that the field is not a simple magnetic field, but a resulting field formed of three elementary magnetic fields :—

1. Magnetic field due to the current circulating in the cable (the less important for guiding purposes).

2. Magnetic field due to the return current in the ground or the sea.

3. Field due to the currents induced in the conducting mass surrounding the loop.

For the secure navigation of aircraft along a route traced by a guide cable, it is necessary to know the following at every instant on aircraft :—

1. The direction of the route and the perpendicular to this route, by two different and independent operations, so as to control them one by the other.

2. The inclination of the aircraft on the route to be followed determined by the guide cable (that is to say, the angle formed by the great axis of the movable object, or its axis of route, with the direction of the guide cable, at the point where this movable object is located).

3. The direction of this inclination (inclination of the aircraft towards the right or towards the left).

4. The number of degrees of this inclination, if possible.

5. The side of the guide cable on which the aircraft is located.

6. The distance separating the aircraft from the guide cable.

7. The horizontal plane of flight.

8. If the guide cable on land is ascending or descending.

The apparatus used by the author consists of three vertical coils—one parallel to the axis of the aircraft, another at right angles to this axis and the third a horizontal coil. All of these coils are embodied in the fuselage structure of an aeroplane, for example, and their ends are connected to a switching arrangement whereby various combinations of connection between the coils can be made. The current induced in these coils is detected by means of suitable amplifiers and telephone, as is done in wireless telegraphy. The direction of the guide line and the perpendicular to the direction of the guide line are obtained by observing the current in the two vertical coils, one of which is parallel to the axis of the aircraft and the other at right angles to the aircraft. The inclination and the direction of the inclination of the axis of the aircraft to the direction of the guide line are obtained by connecting these two coils successively in series, reversing the terminals at each connection. By observing the amount of the current induced in the coils in each connection, the inclination, whether towards the right or the left, can be ascertained. The number of degrees of this inclination may be ascertained by using the well-known radiogoniometric method of measuring the relative values of these currents, but such a device considerably interferes with the reception and can only be used on a few hundred metres for the guide line.

The drift of the aircraft from left to right or from right to left of the guide line is ascertained by connecting in series in the manner indicated above the longitudinal vertical coil and the horizontal coil. The inclination of the guide line is ascertained by connecting in series in the manner above indicated the horizontal coil and the transverse vertical coil. In the trials which have been made, alternating electric current is supplied to the insulated cable at a frequency of 3,000 to 5,000 periods per second. Emergency aerodromes may be provided at suitable distances from each other on the guide line, and these aerodromes may be brought to the attention of pilots by supplying from local lines with current at frequency of, say, 50,000 periods per second.

It will thus be seen that by very simple apparatus, a pilot can determine his route under all weather conditions and in darkness, and if his landing station is equipped with a suitable electrified line, he is assured of a safe landing under these conditions.

The French Government has taken a keen interest in the invention, and has afforded every facility for its trial. Several guide lines have been projected and some already installed (notable from our point of view), one from Paris to Boulogne, with the object of linking through an under-channel cable with guiding lines placed over-ground in this country.

*Abstract of paper read before the Institution of Aeronautical Engineers.

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Correspondence.

"THOSE BREAKDOWNS."

To the Editor of ELECTRICITY.

Your notes in "Current Topics" upon the breakdowns in electricity supply are evidently written by one whose evenings and nights are free from that anxiety which is the constant lot of the electrical power engineer. In the first place, any comparison between gas or water and electricity is inequitable and illogical; the former are stored in quantities permitting of some remedial action being taken if trouble occurs, and before that trouble seriously affects the public convenience. Yet, speaking from personal experience, one knows that water is often cut off from private residences for a few hours, and one is told by water engineers that they do not hold themselves responsible for a continuous supply of water. Station engineers who depend upon a town supply of water, say, from a local company, are warned that it is expected they shall provide sufficient storage upon their works to meet the needs of such works for hours, if not days. Gas engineers are adding to the capacity of gas-holders, and they would be in a parlous state if they had to make and deliver gas to the public at the rate it was consumed.

Now, let us consider for a moment how electricity is supplied. There is no storage. The whole system is connected up in what may be regarded as one of high nervous tension. Consumers are connected to mains laid in streets which are subjected to increasing vibration and carrying vehicle loads for which they were not constructed. Moreover, these streets may be opened by all kinds of authorities, who often do so without proper notice, and in doing so pay little regard to the electricity mains which they come across. Whereas a leakage of gas or water produces purely local effects, damage to an important main may concentrate at the point where this occurs the whole power on the system momentarily, and when the circuit-breaker opens a surge may be set up which will resonate over the whole system and have far-reaching effects.

The principal safety device employed to limit the area of trouble is the "fuse"—a weak link in the chain between the generator and the consumer. It has the inherent defect of its weakness; that, if weak enough to act as a safety device, it melts with a slight increase in current if already fully loaded, while, if made heavier to safeguard against this, it ceases to be of use as a protection. We used to follow the advice given in text-books and classical papers, and network our systems of mains, splitting them into sections with fuses. Experience showed that it was nearly always the wrong fuses which acted, and this led to the abandonment of general networking. Areas are now isolated, with comparatively small networks, which can be inter-connected with adjacent networks by means of boxes or pillars.

Underground boxes have been such a source of trouble that the practice is to get rid of small confined spaces under the streets and place the links, fuses and switches for inter-connection above ground. Even then fuses are called upon to break heavy currents in a fitting which is necessarily kept down to small dimensions. The growth of the supply industry has not been accompanied by a proportionate increase in the controlling capacity of the appliances through which such supply is given. Most engineers know all about the weaknesses of this kind which exist on the systems under their control, but they cannot reasonably ask for the sums of money which would be required to reconstruct the distribution and the appliances on it. According to switch-gear designers, most of the circuit-breakers in use on extra high-tension systems are of too small a k.v.a. rupturing capacity to be safe, and, if their theories be correct, most of us are sitting on a volcano which may erupt at any time.

If a supply undertaking purchases the most modern plant, switchgear and cables from the recognised leading firms in the industry, and these are looked after and operated by carefully selected engineers of experience, these men being paid adequate salaries, say, on the E.P.E.A. scale, what more can those responsible do? Yet, if on such a system one turbine be running on the supply and it breaks down, there must be an interruption of the supply. If in one of the sub-stations one rotary or one motor converter be carrying the supply in a district and a fault develops, that supply will be interfered with for a few minutes. If "one seldom hears of an absolute failure in the public gas supply," it is because (*a*) there is some storage between the production of gas and the consumer; and (*b*) a leak on a main, even if serious, does not allow the gas from the whole system to escape into the atmosphere. On the other hand, electricity does not cause occupants of houses in parallel streets to be gassed in the early hours of the morning, as happened in Bolton a few days ago.

One is occasionally asked for a guarantee that supply will not fail. The answer is that the present charges for electrical energy do not cover an insurance rate against stoppage. To do that would mean the provision, say, of three generating stations and transmission systems, any one of which could give the supply required, and which would be connected up with automatic selective apparatus to the consumer. This was actually done in some munition factories during the war, but is impossible on a commercial basis.

But if one considers the conditions of modern life it must be obvious that everybody takes risks at an increasing rate. We start off on a liner and expect to arrive safely at a destination. Probably we do, but not necessarily so, as witness the *Titanic*. We buy a motor-car and go off on a joy-ride, and how often do we find something to interfere with our plans due to a failure "somewhere"!

Then, if we look at the details which go to make up the most up-to-date arrangements, what do we find at the nerve-centre of an electricity supply system? Something not unlike an electric-bell drop indicator, with tiny screws, single nuts, fine wire coils and a constitution which can hardly be termed "robust" even by the makers. And this is the thing which acts as the brain to a 10,000 or 15,000 kilowatt generator! At the back of the control-panel is a medley of wires and connections which beats a spider's web hollow. We build, as it were, a house of cards in a pyramidical form, balance it on its apex, and express surprise that occasionally a card gets out of place and the whole fabric topples over. Supply is given to an outlying district by a single feeder passing through a mined area, subsidence causes the cable to part at one of the joints, and a day or two elapses before supply is resumed. The record of electricity supply, it might be

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submitted with reason, is an excellent one, considering the conditons under which the supply is generated and distributed.

It is doubtful whether any good purpose would be served by informing the public through the Press of "what caused the mishap." The public can see a huge hole in the ground, but they cannot follow the physical effects which follow, say, from a surge. More good would be done by designers interchanging places with operating engineers for a few months in the year. They would not then place protective relays a few inches off the floor so that the poor operating engineer can never see the condition of some of the most vital parts of a modern control system.

The intrinsic merits of electric lighting are sufficient to cause the public, and especially the lady members of the community, to demand electricity for lighting purposes. Builders state that they cannot find purchasers for houses unless they are wired and supply is available. This, at least, does apply to all better-class premises.

Then there is one contributory cause which is not receiving quite the attention it ought to do, when one deals with failures. That is the want of technical knowledge on the part of the rank and file employed in the electrical industry. Employers seldom offer rewards for knowledge as apart from service. Obviously, service is the principal thing to be considered, but efficient service in a highly technical industry cannot be rendered unless the fundamentals are thoroughly understood. Progress has been too rapid for the ordinary man to follow its trend from practice alone. It would be interesting to know how many of the failures you have recorded have been in any way attributable to bad operation or mis-handling of plant. When a man drops a metal shutter on live terminals, or when a charge engineer disconnects the protective circuit of a running generator, or a switchboard attendant meets his death by pushing a metal rule through the interstices of an expanded metal guard, is it to be hoped that nothing affecting the consumer will result?

It has been well said that reliability is the reward of eternal vigilance. This vigilance must be an attribute of everyone who earns his livelihood in the electrical industry if your columns are to recount few failures. Loose connections, dirt or moisture, and maladjustment of electrical auxiliaries account for many of the preventible interruptions. Accidents due to ignorance or foolhardiness cause most of the others. A few are beyond ordinary skill or care. The difference between the electrical industry and most other occupations is in the instantaneity of the results of neglect or wrong-doing, and their widespread influence.

Why not ascertain yourselves the causes of each breakdown you hear of, by asking the engineer for the facts, and tabulate these (not necessarily mentioning names or places)? Such a symposium would attract attention to the weak points in plant and operation, and might have a valuable educational result. But the cure, in many cases, will be found to cost a lot of money. Anyone who has personal acquaintance with the older undertakings, in particular, must be aware that much of the gear which remains is unsuitable for the higher pressures and greater loads carried to-day, though still serviceable. The "lowest tender" is not always the most economical one, nor by any means the safest. Even the large power companies suffer at times from troubles which cause interferences with supply, though we hear little about them, or, at least, they seldom form subjects of Press comment.

The reliability of supply used to be a text upon which articles were frequently written; then came a lull as better insulating materials were employed, and the mechanical engineer came into the design of electrical plant. Now a complexity is arising in the aggregation of plant which leads to failures by reason, often, of that very complication. No wonder there are engineers who prefer to do without protective devices save those of the simplest kind. Formerly we had the clashing of opinions as to the best "system." Progress has taught us that for economy there is not one, but a combination of systems, and we have as a commonplace extra high-tension generation with some form of low-tension distribution. Gadgets of various kinds are added at every stage from coal heap to consumer's terminals. When one quietly goes over these, one can't help asking: Are all these things necessary, and to what extent do they assist in attaining reliability?

The questions you suggest by your comments must be answered by each of us according to our own experience and opinions formed therefrom. No one else appears to have offered a contribution, so this mite is sent you without any desire of weighting it by a name, but merely as an inducement that others may criticise what has been said by

A STATION ENGINEER.

ELECTRICAL ENGINEERING—FINAL GRADE.

SOLUTIONS TO 1923 EXAMINATION QUESTIONS OF THE CITY AND GUILDS INSTITUTE.

BY EDWARD HUGHES, B.Sc. (Eng.), A.M.I.E.E.

(*Continued from page 676.*)

Q. 12.—The efficiency of a continuous-current motor can be determined with a fair degree of accuracy by the measurement of the various losses separately. Describe this method, and explain why such a method of testing a rotary converter is less accurate.

A. 12.—If the continuous-current motor be shunt-wound, the constant losses, namely the iron, excitation, friction and windage losses, can be determined by running the machine at its rated voltage, the excitation being adjusted to give the correct speed. The connections for this test are shown in Fig. 17, where *M* is the armature, *S* the starter, *V* the voltmeter and *A* an ammeter reading the total current taken by the

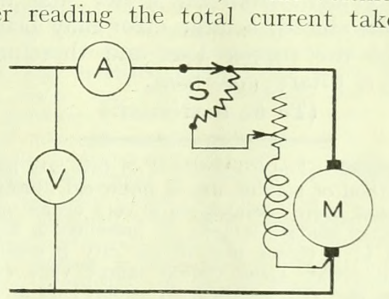


FIG. 17.

motor. The product of the ammeter and voltmeter readings gives the constant losses, the armature copper loss on no-load being so small as to be negligible.

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Should the motor be series-wound, the field should be excited independently; thus, it could be connected in series with a variable resistance across the supply, the exciting current being adjusted to the full-load value and the voltage across the armature varied to give the rated speed. The input to the armature is then equal to the iron, friction and windage losses.

The resistance of the armature circuit is determined by measuring the voltage across the positive and negative brushes with a known current passing through, the armature being stationary. If the efficiency is to be calculated for different armature currents, readings with approximately the corresponding currents should be taken since the contact resistance between the brushes and the commutator decreases with increase of current. It is advisable to take two or three readings for each value of current, the armature being turned to a fresh position for each reading. The resistance of the series winding, if there be one, can be measured in a similar manner.

If w = constant losses as determined above,
I = current taken from mains by motor,
i = shunt current,
$\therefore I-i$ = armature current,
and if r = corresponding resistance of armature circuit (including series winding, if any),
and V = supply voltage,
then input to motor $= IV$
losses in motor $= w+(I-i)^2r$
$\therefore$ output of motor $= IV-w-(I-i)^2r$
and efficiency of motor $= \dfrac{IV-w-(I-i)^2r}{IV}$

In the case of a rotary converter, the constant losses can be determined by running the machine as a shunt motor on no-load as described above. The determination of the copper loss in the armature, however, is more awkward, since this loss depends upon the number of phases for which the converter is wound and also upon the P.F. of the alternating current. If r be the armature resistance as measured above, and I be the current on the D.C. side, the copper loss in the armature is given fairly closely by kI^2r, where k has the following values for 3-phase and 6-phase rotaries:—

P.F.	*3-Phase.*	*6-Phase.*
1.0	0.56	0.28
0.9	0.86	0.51
0.8	1.3	0.80

It will be evident from the above that unless the factor k is introduced, a large error may occur in the calculation of the copper loss, and therefore of the efficiency of a rotary converter.

(To be continued.)

Festive Liverpool.—The Corporation of this city have hit on a very novel method of making use of electrical illuminations, by decorating one of their tramcars in a very ornate manner with a large number of electric lamps. It presented a truly brilliant spectacle, and in a recent tour of the city it created quite a sensation. Altogether 5,209 Osram lamps were employed in the decorations, and they represented a total load of 140 amperes or 470 kilowatts when they were all alight. The floral and art designs were arranged for steady illumination, but several sections were wired to flashers, giving changing coloured effects. We understand that the car will remain a permanent feature, and will be brought out on all suitable occasions in Liverpool when illuminations and other decorations are the order of the day.

V.I.R. CABLES—THEIR MANUFACTURE AND SELECTION.*

(Continued from page 655.)

In the first place it is not agreed by all of these "masters" that vulcanised rubber is a new substance in a chemical sense, that is to say, you never have the definite chemical reaction which takes place, invariably under all conditions, as we have, say, in the formation from hydrogen and chlorine of hydrochloric acid.

For instance, it is found that with an average "mix," approximately 100 parts of rubber will combine with 2.5 to 3 parts of sulphur before correct curing is attained, but if to the same "mix" is added a violent "accelerator," even in so small a quantity as, say, $\frac{1}{4}$ of 1 per cent., it is found that the proportion of "combined" sulphur in the vulcanised product is as low as 0.5, or even less, per 100 parts of rubber. The two articles would not be exactly alike, it is true, but the fact remains that in each case you have the fully vulcanised product with different proportions of sulphur and rubber—a condition which appears to negative the claim for a new chemical substance.

Yet on the other hand, we have the claim argued very ably by acknowledged "masters" that in the vulcanising of rubber a definite chemical reaction does take place, and to those who are interested in this, I would refer them to the *Rubber Age*, of June, 1923, in which appears the report of the third Cantor lecture by Dr. H. F. Stevens, who deals with this contention.

It will be of some immediate interest to quote Dr. Stevens from his first Cantor lecture on what "vulcanisation" is, as follows:—"The term 'vulcanisation' is applied to a change which rubber undergoes, and by which its physical and chemical properties suffer *subtle* modifications," the change being brought about generally by heating the rubber mixed with sulphur.

"Rubber after vulcanisation (*a*) becomes less sensitive to changes of temperature, that is, it neither hardens in cold weather nor becomes sticky in the sun; (*b*) loses a part or the whole of its adhesive qualities, has a limited capacity for swelling in liquids and becomes 'insoluble' in the ordinary solvents which dissolve raw rubber; (*c*) acquires improved physical properties—that is, the breaking strain and length at break are increased and it recovers to its original shape completely after distortion."

To give another definition of interest, I quote Dr. Schidrowitz from his paper to the Institution of Rubber Industry of January last, in which he gives a definition in terms mainly of the vulcanisation itself, as follows:—

"Vulcanisation is a process involving the interaction of rubber and of sulphur (or sulphur compound), which profoundly modifies and improves the thermal and physical properties of the rubber."

Now both of these "masters"—I prefer this term to that of "experts" as applied to this art—have made their investigations upon, and are thinking, in terms of vulcanised rubber for uses other than electrical, so that when we add to the problem the additional requirements of insulation, resistance and dielectric strength, we realise how very involved is this manufacture.

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* Lecture delivered by William Lang, M.I.E.E., before the National Assoc. of Supervising Electricians, November 13, 1923.

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In fact, it is not too much to say that the process of vulcanisation is so subtle in its nature that the manufacturer himself cannot be absolutely certain that when the cable comes out of "the cure" it will test out to the standard he had fixed for himself, although he has taken every precaution in the various stages of manufacture. This means that it must not be assumed because the exact materials and details of a specification have been closely adhered to, that necessarily the finished product will embody all the requirements of a high-grade V.I.R. cable.

A bad "cure," like a loaf of bread which has not "risen," and will not be improved by refiring, cannot be "re-cured," but must be scrapped, although, unlike the bad loaf, which can be seen and felt to be bad, the badly cured cable might be passed off as quite sound until the working of the installation broke down and exposed the trouble.

This will be appreciated by a further quotation from Dr. H. P. Stevens, where he deals with the changes under vulcanisation:—"It is important to remember that vulcanisation is a gradual process in all its manifestations. These are no sudden changes. Raw rubber passes imperceptibly into vulcanised rubber, and as the change proceeds the properties become more and more differentiated from the raw material. The rubber becomes harder, less distensible and less affected by solvents, until eventually the stage of hard rubber or ebonite is reached, when the contrast between the raw material and the vulcanised product is greatest, and a substance is obtained differing widely from the raw material in almost every respect."

This, then, is the problem of the manufacturer, that he will "cure" his cable efficiently, and do so time after time with unrelenting reliability. The success of this operation depends almost entirely upon the practical experience of the manufacturer.

Sulphur is, of all the constituents of manufactured rubber, the one which possesses the greatest influence upon the general excellence of the finished article. The term given to the amount of sulphur fixed by the rubber is that of "sulphur of vulcanisation," and this is rarely more than 3 per cent., and usually less. Some free sulphur is always present, and the success of a cable depends very largely on the smallness of this quantity. "Over-vulcanisation" does not consist simply in a high co-efficient of vulcanisation, but in one obtained under unsuitable conditions, either of temperature or of time or of sulphur. Of these causes too high a temperature is the commonest one, while too short a time is the most usual cause of "under-vulcanisation."

Following upon vulcanisation the cable is passed out to "the test," where it is immersed in water tanks, usually for twenty-four hours, and a test of the insulation resistance then made.

The final operations consist of braiding and compounding either upon the cable as it is, that is, single conductor, or where two or more "singles" are made up flat or in a strand to form what we style "multi-core" or "poly-core" cables. Should lead sheathing or armouring, or both together, be called for, the operation of braiding is omitted until the final stage. In some cases larger cables may have a serving of jute compound as a finish, and frequently they are left without any outer finish of this description.

(To be continued.)

Questions and Answers by Practical Men.

RULES.

QUESTIONS: *We invite our readers to send us questions, preferably on technical problems that have arisen in actual practice. Questions which we consider of sufficient interest to our readers will either be replied to under "Answers to Correspondents" or replies will be invited from our readers. One shilling will be paid for the question which we select for competitive replies in this column.*

ANSWERS: *A fee of 10s. will be paid for the answer which we consider show the greatest merit, and 5s. for the one we select as second best. In judging the replies importance will be attached to clearness and conciseness, as well as accuracy. The Editor reserves the right to make no award, or to accept only one reply, if, in his opinion, the answers received do not possess sufficient merit. Competitors desiring the return of their manuscripts, if unaccepted, should enclose stamped addressed envelope.*

Write on one side of the paper only, and if diagrams are sent, draw them on a separate sheet of paper attached to the manuscript. Competitors may adopt a "nom de plume," but, both in the case of questions and answers, the competitor's real name and address must be sent with the manuscript as a guarantee of good faith. No correspondence will be entered into with regard to successful replies. The Editor's decision is final.

Commencing with Question No. 101, a Diploma of Merit will be awarded to the six competitors who win the first or second prize the most times during the next twelve months.

The words "Questions and Answers" or "Q" and "A" should be placed at the top left-hand corner of all letters intended for this column.

QUESTION NO. 173.

I am employed on railway signalling, and I do not understand the construction and principles of operation of the following:—

(1) Track relays, galvanometer type.
(2) Track relays, vane type.
(3) Detection relays, polarised vane type.
(4) Purpose of shading bands on latter.

I would appreciate the details of operation, etc. The tracks are single-phase, 25 to 33½ cycles.—"JACK ALLEN."

QUESTION NO. 174.

Can any reader inform me of the process by which accumulators are treated to enable them to be put on the market in what is known as "a dry and fully charged condition," i.e., only requiring to be filled with dilute acid and to be given a short freshening charge?—"C. R. HARDY."

(Replies to Questions Nos. 173 and 174 must be received not later than January 5, 1924.)

Various Items.

Social.—A dance, arranged by members of the staff of the Sun Electrical Co., Ltd., was held on Saturday, December 8. This was voted a complete success, and it is hoped will be the forerunner of many similar functions.

Meetings.—There will be a Wireless Section meeting of the I.E.E. at the Institution on Wednesday, Jan. 2, at 6 p.m. Paper: "Some Experiments on the Screening of Radio Receiving Apparatus," by R. H. Barfield, M.Sc. (Student).

Smoking Concert.—Lt.-Col. F. A. Cortez-Leigh, T.D., R.E., presided at the Electro Harmonic smoker held at the Caxton Hall on Tuesday, 11th inst., when opinion was unanimous that the programme was excellent, chief credit going to Mr. Joseph Cheetham, tenor, and Messrs. Nickolds and Howe for their humorous harmony. The attendance was good, but one misses the faces of many of the old habitués. Why don't they turn up? The hall is comfortable, and there is a nice lounge.

Indo-China.—The report of the commercial situation in Indo-China has just been issued by the Dept. of Overseas Trade, and may be obtained from H.M. Stationery Office or ELECTRICITY Office, price 11d., post free. The information contained therein is of interest to all who are anxious to push trade in these Eastern territories. A similar report, price 1s. 8d., post free, deals with the trade conditions in South Africa, and contains an account of the progress which is being made by Germany in recovering the great trade in electrical goods and apparatus which it held in pre-war days. It is up to British manufacturers to fight hard to retain their supremacy, and we have no doubt that this will be done. The pamphlet is well worth careful perusal.

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Electrical Porcelain for Chile.—A short report on the market for electrical porcelain in Chile has been issued by the Department of Overseas Trade, 35, Old Queen Street, London, S.W.1, from whom copies may be obtained free on application.

Removal.—Messrs. S. Davis and Co. (publishers of the *Electrical Engineer's Year Book* and *Where to Buy Everything Electrical*) have removed their offices from 30 and 31, St. Swithin's Lane, E.C., to more commodious premises at Aldwych House, Aldwych, W.C.

Meetings.—The Junior Inst. of Engineers will meet on Friday, January 4. Lecturette, "Economy of Fuel by Removal of Soot from Boiler Tubes," by L. Manico (Member) (exhibits and diagrams). On Tuesday, January 8, there will be a dance at the Cannon Street Hotel at 7 o'clock. On Friday, January 11, paper, "Concrete Engineering," by C. O. Mourant, M.I.Struct.E. (Chairman) (slides).

Berlin.—The entire telephone system of Berlin, Germany, is to be converted to automatic working as rapidly as engineering and economic conditions will permit. The Strowger automatic equipment has been chosen as suitable, after a careful trial before a decision was made. The equipment will be manufactured by Messrs. Siemens and Halske, who have been licensed under the same patents as the Automatic Telephone Mfg. Co., Ltd., of Liverpool.

Royalty at the Coliseum.—On the occasion of the Royal command performance at the Coliseum on Thursday, 13th inst., special decorations of a very striking and novel nature were arranged under the direction of the stage manager, Mr. H. Crocker. Light and colour played a very prominent part in the scheme of decoration, the boxes and circles being garlanded with festoons of bay leaves, among which were hidden a large number of Osram colour-sprayed gasfilled lamps, providing a soft flood of well diffused and delicately tinted illumination in a variety of delightful colours.

"The Fortieth Milestone."—This is the title of a beautifully illustrated reprint from "Men of the Day," recording forty years' achievement of the Western Electric Co., Ltd., in the advancement of international communication. From 1883 to 1923 represents a lifetime of marvellous progress in electrical science, much of which is due to the enterprise of the men who have at various times during that period been associated with the company, and the members of the staff, for whom this work has been reprinted, can feel right honest pride in its record. We hope that the men now in control will all be spared to see the company's jubilee described in a yet more ambitious manner.

Cable Corrosion.—An interesting paper, entitled "The Corrosion of Lead-covered Cables by Electrolytic Action," was recently read by Mr. S. C. Bartholomew, M.I.E.E., before the London Centre of the Inst. of P.O. Electrical Engineers, and it has now been reprinted in pamphlet form. Including the discussion, it represents a book of 72 8vo pages, in which are a number of clear diagrams, and it can therefore be recommended to all readers who are interested in this particular section of electrical work. The price is 1s. 6d. net post free from Messrs. S. Rentell and Co., Ltd., 36, Maiden Lane, London, W.C.2.

Personal.—Mr. A. J. Rayment, head of the technological books department at Messrs. Sir Isaac Pitman and Sons, Ltd., is severing his connection with them at the end of the year. Pending other arrangements, any communications of a personal character may be sent to him c/o Theodore Stevens, Esq., M.Inst.C.E., M.I.E.E., 50, Lincoln's Inn Fields, W.C.2.——Mr. Sidney Pare Ives, for eight years chief electrical engineer to Messrs. Higgs and Hill, Ltd., has resigned his appointment in order to take an active interest in Messrs. Pinching and Walton, general and electrical engineers and contractors, 52, Cannon Street, E.C.4, to which address any business communications can be forwarded.

Plant Wanted.—The Egyptian Ports and Lights Administration invites tenders for stores for the year 1924-25, including belting, electrical articles, files, etc.——The National Sanitary Works at Buenos Aires invite tenders for the supply and erection of steam-driven electrical generating plant for the waterworks at Posadas.——Tenders are invited by the Secretary, Public Works Tenders Board, Wellington, for the design, manufacture, supply, erection, testing and maintenance for a period of six months of an hydro-electric power station at Arapuni, on the Waikato River, to include machinery and plant, outdoor step-up transformer station, buildings and all accessories. Particulars from D.O.T. (Room 52), 35, Old Queen Street, London, S.W.1.

Trade Notes.

Folder B.C. 3187 from the **General Electric Co., Ltd.**, is devoted to the Gecophone constructor's set. The parts, which are all ready for assembly, make up a Model B two-valve set.

A catalogue of wireless batteries and accessories, No. 50A, has been issued by **A. H. Hunt, Ltd.**, of Tunstall Road, Croydon, and deals with various types of apparatus which should find a ready market among dealers in these goods. The company directs attention to their Hellesen Dry Batteries of all types for wireless, and the High and Low tension types in particular, which they claim are eminently suitable for use with the new wireless valves. There is also a remarkably fine range of electrical measuring instruments, spring-controlled and dead-beat, shown at the end of the catalogue, which is well worth writing for.

Leaflet No. 1348, which has just been issued by the **General Electric Co., Ltd.**, illustrates and describes the "Easiso" electric sewing machine motor for A.C. and D.C. circuits. It is a very neat little machine, which is suitable for practically all voltages, and can be connected promptly to any ordinary lamp socket. In addition, the motor is arranged so that it can be used on all models of sewing machines, and, as the price is moderate, it should most certainly meet with a ready sale. Copies of the leaflet are available for the trade, and can be obtained on proper application to the company, at Magnet House, Kingsway, London, W.C.2, or any of the provincial branches.

A well-printed catalogue of Sunlite reflectors for show-window lighting has come to hand from the **Sun Electrical Co., Ltd.**, of 120, Charing Cross Road, London, W.C.2. It deals with the company's well-known line of reflectors which was introduced by them over twenty years ago, and shows models particularly of S 50 and S 51, which have been developed to give still further efficiency for the illumination of show windows. Copies of the list will be willingly sent to installation contractors and the trade generally on official application.

The December issue of their regular monthly trade price list has been issued by the **Siemens and English Electric Lamp Co., Ltd.**, of 39, Upper Thames Street, London, W.C.2, and will, as usual, appeal to all electrical contractors and factors, to whom it will be willingly sent on application.

A comprehensive catalogue of electrical appliances, many of which should find a ready sale this Christmas season, has just been issued by **Electrico, Ltd.**, of 139, Bournemouth Road, Parkstone, Dorset, and we can commend it to the notice of our readers. It is profusely illustrated, and in its present loose-leaf, perforated form should prove most useful for retail trade purposes.

A card circular issued by the **Cambridge and Paul Instrument Co., Ltd.**, illustrates and describes briefly the Cambridge Contact Pyrometers for Surface Temperatures. Readers desiring further particulars should write to the company, at 45, Grosvenor Place, London, S.W.1, and ask for List No. W194, which will be sent willingly on request.

"Moonstone, Glassware and Reflectors" is the title of a new catalogue of glassware for use with gasfilled and vacuum lamps, which has just been issued by **Siemens and English Electric Lamp Co., Ltd.**, of 38, Upper Thames Street, E.C.4. It illustrates numerous very effective designs in reflectors for direct and semi-indirect illuminating purposes as well as dustproof one-piece and two-piece glass units, all of which should find a ready market among installation contractors and dealers, to whom the catalogue can be recommended.

Publication No. 949 deals with the Alternating Current Control Gear manufactured by **Messrs. Veritys, Ltd.**, of Aston, Birmingham. It is a well-illustrated catalogue, containing clear details and diagrams of the different types of starting panels, air break rotor starters, air break direct starting switches, star delta starters, auto-transformer starters and similar apparatus for which the firm have for so long held a high reputation. The catalogue should appeal to all Central Station engineers and power contractors, and will be sent on receipt of usual trade application.

A new catalogue just issued by **Worthington-Simpson, Ltd.**, of Queen's House, Kingsway, London, W.C.2, deals with the latest designs of cooling towers manufactured by the company, and will appeal to Central Station engineers both in this country and abroad. Details are given of various important contracts for these towers which have been carried out in different parts of the world, and for which the makers hold a very high reputation.

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A POPULAR SCIENTIFIC WEEKLY JOURNAL
ELECTRICITY
A PRACTICAL TRADE JOURNAL

DECEMBER 28, 1923.

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SMALL ACCUMULATORS.*

By A. E. Underwood, Farnworth, Lancashire.

Now that so many users are to be found for small accumulators, the writer thought it an opportune moment to place before the members of the N.A.S.E. an account of how these useful but sometimes expensive accessories can be made at home at a small cost. There is, however, one point which requires particular note, and that is, the maker of the accumulators in question must have access to a direct current of some description, such as a D.C. lighting supply, the reason being that the first "formation" of the plates is rather a slow job and quite beyond the primary battery. If carefully made, the accumulators possess a good life. To start with, the size of the plates can be decided by the containers which are to hold them, and any rectangular glass jars or old celluloid cases can be used for the purpose. Having decided on the size of the plate, the first job is to make a mould for the grid. Now, there are many ways of making a mould for this job, but after a trial of many types, the one described gave the best *grids*.

A piece of sheet brass about $\frac{3}{8}$ in. thick and 2 in. overall larger than the grid is obtained, and I think it will be as well if we fix on some definite size, say, a 4 in. by 3 in. grid; we shall therefore require a piece of brass 6 in. by 5 in. by $\frac{3}{8}$in. In this brass the pattern of the grid is cut, and the quality of the cast grid will prove to the maker how skilful he is with saw, chisel and file. The type of grid favoured by the writer is depicted below, and gave very satisfactory results.

As is generally known, the lead accumulator undergoes continual expansion and contraction during its stages of charge and discharge, and for this reason large masses of active paste are to be avoided. With this point in mind, we make a fine mesh grid as Fig. 1. The channels are cut with $\frac{1}{8}$ in. and $\frac{3}{16}$ in. chisels to a uniform depth of $\frac{3}{16}$ in. and should be very slightly tapered towards the bottom. It will be noted that the lug side is $\frac{1}{4}$ in. by $\frac{3}{16}$ in. whilst the front limb is $\frac{3}{16}$ in. by $\frac{3}{16}$ in. So also is the top and bottom limb. The lug is best placed at one end and can safely be made $\frac{1}{2}$ in. wide. The best way to mould the grid is to put the brass mould on a small tripod with a Bunsen burner under it. A piece of mixture of lead 95 parts and antimony 5 parts is placed on the mould which, when hot enough, will cause the mixture to melt. The molten mixture should be distributed over the meshes of the mould and the surplus scraped off with a piece of smooth wood and the gas turned off.

After about two minutes the lead will have set, the mould then being placed in a bucket of cold water. By inserting a pen-knife blade under the lug end, the grid can be stripped from the brass mould. If the mould should cause the grid to stick badly in any place, it requires the taper increasing a little at that point. When the mould is in proper form, it will be quite possible to make a grid in five minutes, so a little time is well spent at first getting the mould correct.

When the number of grids have been cast, with a few spares, they can be gone carefully over for cracks and trimmed with the point of a sharp pen-knife. It will be noted that no provision is made for holders, but this is not necessary in this type of accumulator.

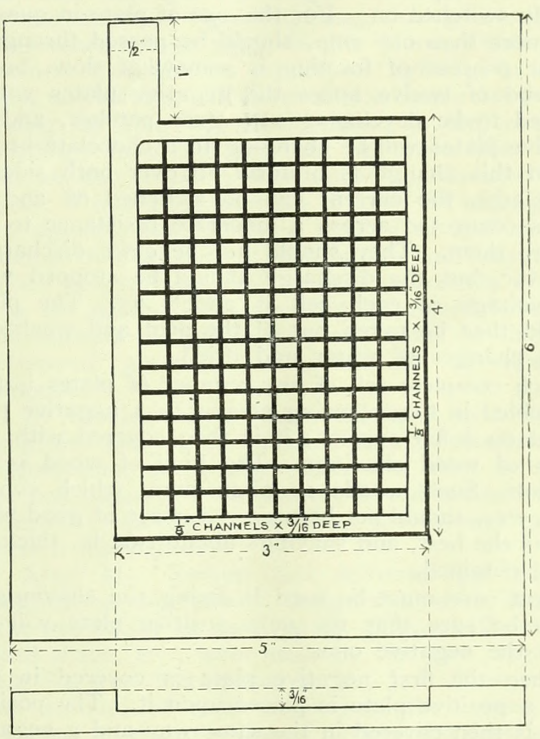


FIG. 1.

The next process consists of filling in the grids with paste, and perhaps the following method will be new to a few. No red lead is used for the positive plates. All the grids are pasted on a sheet of glass with "litharge" and ammonium sulphate. The "litharge" should be carefully chosen and should be in powder form. Any "litharge" which is in the form of tiny flakes should be discarded. The ordinary commercial ammonium sulphate can be used, and is very cheap.

*Prize article in *Contact*, November, 1923.

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A saturated sol. of the amm. sulphate is used to make the "litharge" into a good stiff paste, and here lies the secret of success. The paste must not be hard and lumpy, or the plates will be poor, nor must it be too sloppy to work. It quickly sets up to a certain point, liberating copious doses of ammonia gas, so too much should not be made at one batch. Sufficient for three or four plates is easily worked.

The grid is laid on the sheet of glass and the paste well pressed in the grid. It should then be *slid* off the glass, and *not* lifted, and the other side treated likewise. It will be found an easy method of finishing the plate after pasting to draw it once or twice on each side on the glass plate, as this method leaves the plate with a nice flat finish, after which it should be stood up to dry for at least eighteen hours in a dry room, but must *not* be hurried by outside heat. When all the plates are dry, they are prepared ready for forming. Short pieces of lead fuse wire are twisted tightly round each lug, and the plates are then put into any old jam jars, preserve jars, celluloid cases, or anything that will hold two plates. They are then coupled up in series. A quantity of pure sulphuric acid, sp. gr. 1.84, should be obtained, and this must be let down with pure water (either distilled or rain water) until it has a sp. gr. of 1.12.

This acid, when cool, is used to fill the containers up to the tops of the plates, and the current immediately switched on. For the size of plate in question not more than one amp. should be passed through.

The process of forming is somewhat slow, but at the end of twelve hours the negative plates will be noticed to be developing very grey patches, and the positive plates will be changing to a chocolate brown. When this change is uniform all over both sides of the plates, the current can be switched off and the plates connected across a moderate resistance to discharge them. They should not be *quite* discharged, however, but the discharge should be stopped when the voltage of each cell is about .75. The plates should then be taken out of the acid and washed in three changes of water and dried.

Each complete cell of any number of plates is then assembled in the following manner:—A negative plate is put on a flat surface; it is then covered with thin strips of wood shavings. The kind of wood is important. Such woods as pitch pine, which contain resin, etc., should not be used. A piece of good white pine is the best, and shavings about 1-64 in. thick are easily obtained.

Great care must be used in fixing the shavings so as to be sure that the next positive plate will not touch the negative one.

When the first negative plate is covered in this way, a positive plate is placed upon it. The positive plate is then covered in the same way and a negative placed upon that. Of course, all negative lugs are placed at one end, and all the positive lugs at the other.

In this way the cell is built up, say eleven plates, five positive and six negative. The batch of plates are then carefully bound together with tape to enable them to have any shavings trimmed. This is best done with a pair of small snips. The lugs of each side are then burned together with a small blow-pipe, and the connecting terminal fixed at the same time. All that then remains to be done is to fix the cell in its container, fill with acid of 1.12 sp. gr., and charge slowly until the cell gases freely.

In the experiments of the writer, which spread over a number of years, it was established, amongst other things, that the wood insulation fixed between the plates in the manner described does not in any way diminish the output of the cell, whilst forming a compact block of plates, which makes it almost impossible to short-circuit through loose paste, and makes an admirable construction for withstanding vibration.

THE ELLA CONVERTER AND BATTERY CHARGER.

Illustrated in Fig. 1 is the Ella converter, a rotary machine for charging 4/6 volt accumulators from 100 to 250 volt D.C. mains, to which it is directly connected. It runs at a speed of about 2,000 r.p.m. and is substantially constructed. Insulated adjustment springs are provided for the commutator brushes. Two 20 amp.-hour accumulators can be charged in parallel.

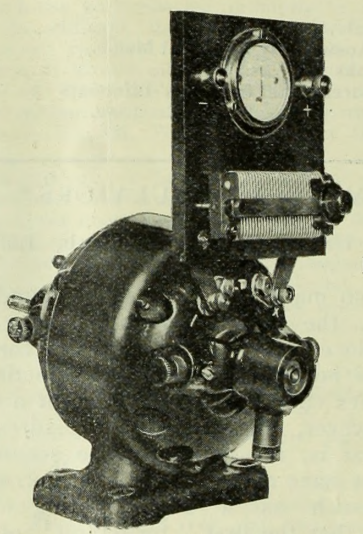


FIG. 1.

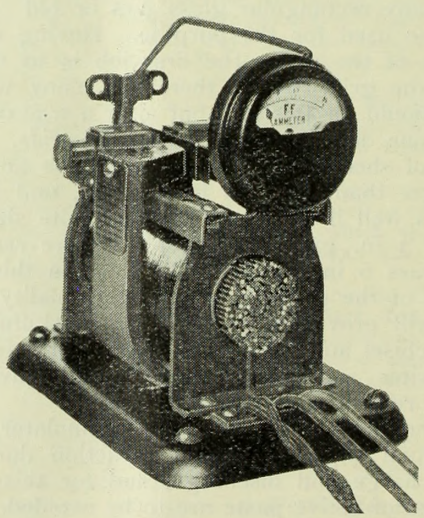


FIG. 2.

The weight of the machine is 15 lb. and measures approximately $6\frac{1}{4}$ in. by $5\frac{3}{4}$ in. by $8\frac{3}{4}$ in.

For charging from A.C. mains the Ella vibrating rectifier of the full-wave pattern has been designed.

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This machine is illustrated in Fig. 2, a plan view being shown in Fig. 3. The simplicity of the arrangement is well shown. An output of 3/10 amps. at 9 volts can be obtained, the current being altered by adjustment of the two carbon brushes which make contact with copper plates on the vibrating armature. This adjustment is effected by means of the two large brass

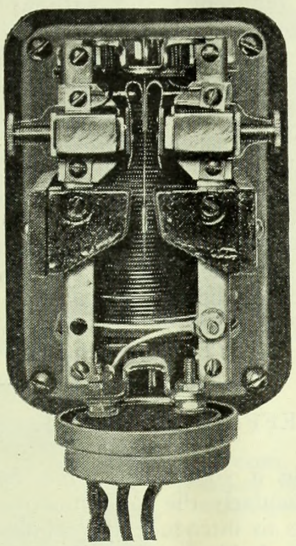


FIG. 3.

screws. Besides indicating the value of the current flowing, the ammeter shows whether the battery is correctly connected or not.

Messrs. Lionel Robinson and Co., of 3, Staple Inn, W.C.1, are handling these machines.

THE "KINGSWAY" WATERTIGHT WIRING SYSTEM.

A second and greatly enlarged catalogue of this wiring system has recently been issued by the General Electric Co., and should prove of direct interest to installation contractors, both at home and in the Colonies. In it is a section dealing with an entirely new departure, viz., "watertight" wiring, which has been designed to meet the demands for a perfectly reliable and efficient watertight surface installation. The principal feature of this system is a patent gland, which is made in various sizes for single-core round section and twin- or three-core oval section lead covered cable, thus enabling this type of cable to be used in conjunction with ironclad switches, fuseboards and other apparatus possessing watertight qualities, such as could hitherto only be used in conjunction with screwed conduit.

The gland consists of four parts—a body or plug portion made from brass or other suitable metal, screwed $\frac{3}{4}$ in. Electric thread on the outside and with either a circular or oval hole throughout its length, according to the type of cable with which it should be used. Across one end of this screwed plug a wide slot is milled, leaving two "D" shaped pieces between which the washer fits. This washer has a hole of the same size and shape as the hole through the plug to which it is clamped by a hexagon nut. The locknut is used to clamp the plug in the required position to the junction box or other apparatus. A short length of No. 18 s.w.g. lead wire is wrapped round the cable before the washer is put into position, and this lead wire is compressed into the recesses between the cable and the body of the plug, thus making a perfectly watertight joint and ensuring continuity throughout the installation.

In addition to the special details already referred to, the list contains a very useful selection of such accessories as fixing screws, Rawlplugs, main switches, fuses, lampholders, plugs and switches.

THE APPLICATION OF SCIENTIFIC ILLUMINATION IN PRACTICE.

At the meeting of the Illuminating Engineering Society, on December 11, a discussion on the above subject was opened by Messrs. Geo. Herbert and R. A. Ives. In the introductory part of the address the authors pointed out the great change that had taken place during recent years. There was now a much better appreciation of the need for good lighting and the idea of avoiding glare, and even technical terms such as the foot-candle were much better understood.

Great stress was laid on the importance of authentic data, showing the relation between bad lighting and accidents, or diminution in output. Information of this kind formed valuable ammunition for those commercially concerned with lighting development. The authors also gave a simple summary of the chief requirements of "good lighting," using as a basis the recommendations made in the Home Office Departmental Committee's report on lighting in factories and workshops. Reference was made to the efforts being made by the Home Office, in conjunction with leading industrial councils, to pave the way for standards. From a commercial and industrial standpoint it was most desirable to have the main principles of lighting outlined by a recognised authority representative of producers, distributors and consumers. A point of great consequence was uniformity of practice on the part of lamp makers in regard to sizes and dimensions of lamp-bulbs; variations in this respect rendered accuracy in prediction of illumination impossible.

In conclusion, it was remarked that while the engineer had highly technical data to disseminate, the information put before consumers must be shorn of technicalities, and every effort should be made to enable them to visualise the benefits they would gain from better illumination.

After Mr. Herbert had delivered the address, a number of experiments, designed to show how readily the eye might be deceived by different effects of light and shade, etc., were made by Mr. Ives, and the discussion was then opened by Mr. J. S. Dow, who gave an account of some aspects of the Society's work bearing on the collection of data on the lines advocated by the authors. An interesting discussion took place, in which Mr. W. R. Rawlings, Mr. Haydn T. Harrison, Capt. E. Stroud, Mr. W. E. Bush, Mr. G. Campbell, Mr. J. G. Clark and Mr. J. F. Caine joined. Mr. L. Gaster, who presided, wound up the discussion, and after Mr. Herbert had briefly replied to some of the remarks made, it was announced that the next meeting would be held on Tuesday, January 22, when a discussion on "Co-ordination of Research in Illuminating Engineering" would be opened by Mr. J. S. Dow.

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PROBLEMS IN TELEPHONY, SOLVED AND UNSOLVED.*

BY PROFESSOR J. A. FLEMING, M.A., D.Sc., F.R.S.

(*Continued from page 676.*)

If we begin with a just audible speech sound, which we have seen corresponds to a variable air pressure of about 0.001 dyne per cm^2 (R.M.S. value) for sounds of frequency about 1,000 p.p.s., and if we then increase the amplitude by about 7 napiers, which brings the R.M.S. pressure to about 1 dyne per cm^2, since $(2.71828 \ldots)^7 = 1{,}096$, we shall have a sound the loudness of which corresponds to the maximum articulation as judged by the percentage of correctly heard test-syllables transmitted. If the amplitude is increased still more the articulation falls off again, as shown by the curve in Fig. 2. The ear is "deafened," as we say, by very loud speech. Hence there is a certain amplitude which gives the maximum of telephonic speech articulation or intelligibility. By means of the filters, which are artificial telephone lines constructed with inductive resistances in series of capacities in parallel, or vice versa, it is possible to attenuate very rapidly speech currents of a certain range of frequency either above or below certain selected limits. The results of this filtering on telephonic speech transmission are very remarkable. According to the researches of Harvey Fletcher and those of Crandall and Mackenzie a filter which cuts off all currents of frequency below 500 p.p.s. stops 60 per cent. of the speech energy but only 2 per cent. of the articulation. This means that the speech is greatly decreased in loudness but not much in clearness or intelligibility. On the other hand, a filter which cuts off all frequencies above 1,500 eliminates only 10 per cent. of speech energy but reduces the articulation by 35 per cent. This means that the speech is not much reduced in loudness but is very reduced in clearness. A filter which cuts off all frequencies above 3,000 p.p.s. has as bad an effect on articulation as one which cuts off all below 1,000 p.p.s.

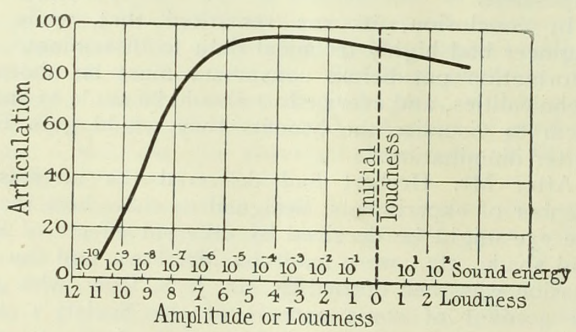


FIG. 2.—CURVE SHOWING THE "ARTICULATION" OF A TELEPHONE CIRCUIT IN TERMS OF LOUDNESS OF THE SPEECH (HARVEY FLETCHER).

Some speech sounds, such as the vowels u, o and e have characteristics carried by frequencies below 1,000, but the fricative consonants denoted by the letters i, z and th have their specific qualities conveyed by high-frequency harmonics and are greatly affected by cutting off frequencies above 3,000 p.p.s.

* Lecture delivered before the Institution of Electrical Engineers, to whom we are indebted for the illustrations.

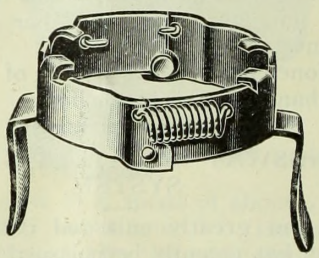
The sounds denoted by the letters f, v and th are most difficult to hear and are responsible for 50 per cent. of the mistakes of telephonic interpretation. Their current articulation seems to depend on the transmission of harmonics of very high frequency. The general conclusion is that any telephonic apparatus designed for good speech transmission must transmit with equal efficiency and without distortion sounds of all frequencies from 100 to 5,000 p.p.s. Although the greater part of the sound energy is transmitted by currents and air waves of frequencies below 1,000 p.p.s., yet the essential characteristics of speech, and especially of consonant sounds, are conveyed by frequencies much higher than 1,000 p.p.s. and up to 5,000 p.p.s.

The poor transmission over ordinary telephonic circuits of certain consonants such as f, v and th is responsible for much difficulty, especially in the case of the names of digits such as *five*, *nine* and *three* in calling numbers.

(To be continued.)

AN EFFICIENT SHADE CARRIER.

To provide a solution for the difficulty of fitting shades, particularly the long narrow type in which it is impossible to introduce the whole of the hand, on ordinary lamp-holders, the G.E.C. have introduced a device under the name "Titan."



"TITAN" SPRING SHADE CARRIER.

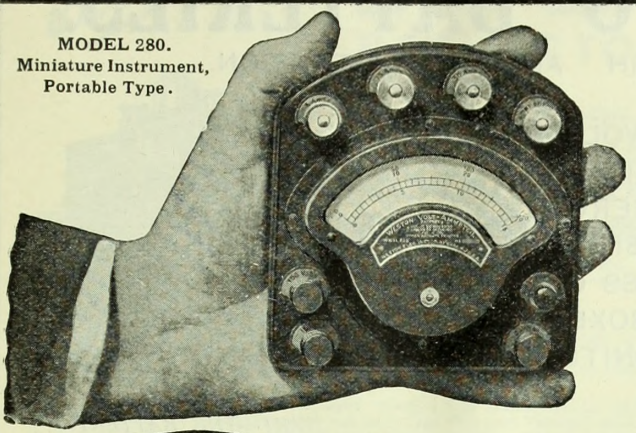
This consists of a ring provided with four teeth projecting inwards and split across a diameter, the two parts being kept in position by spiral springs. The two ears, when compressed between the thumb and finger, cause the two halves to gap open, hinging on the two rivets clearly shown in the illustration. The ring can then be slipped over the barrel of the lamp-holder, and upon releasing the ears the teeth on the inner side of the ring grip the tread of the lamp-holder, the shape of the teeth being such that the weight of the shade increases the effectiveness of the grip.

Agriculture.—Readers who are interested in the subject of electricity in agriculture and in the growth of plants, should make a point of reading "Growing Crops and Plants by Electricity," by Dudgeon, price 1s. 8d., post free, from ELECTRICITY Office. It is well worth careful perusal, particularly at a time like the present, when everything should be done to develop home production.

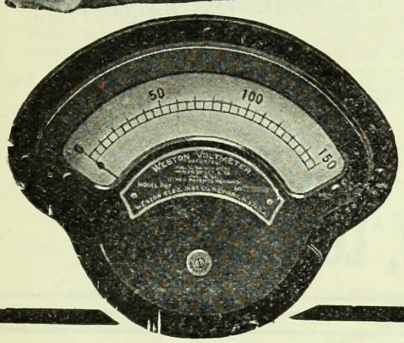
Diesel Engine Users Association.—Mr. A. W. A. Chivers (British Electrical Federation, Ltd.), has been elected president of this Assocn. for the year 1924, and with regard to the hon. secretaryship, arrangements have now been made to relieve Mr. Percy Still of some part of the duties which he has attended to during the last ten years by appointing joint hon. secs. Messrs. Percy Still M.I.E.E., and Geoffrey Porter, A.M.I.C.E., have been so elected.

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WESTON ELECTRICAL MEASURING INSTRUMENTS



MODEL 280.
Miniature Instrument,
Portable Type.



MODEL 267.
Miniature Instrument,
Switchboard Type.

WESTON Miniature Precision D.C. Instruments.

A New Group of Small D.C. Instruments in Switchboard Portable and Battery Testing Types.

These instruments are of the pivoted moving coil permanent magnet type, and have been designed to meet every requirement of D.C. measurement where small amounts of energy are involved.

The group comprises about 400 standard ranges, including Ammeters, Voltmeters, Mil.-Ammeters, Milli-Voltmeters and Volt-Ammeters.

The instruments are accurate, dead beat and reliable, and their construction throughout embodies those refinements of mechanical work and beauty of finish which are characteristic of all WESTON Instruments.

The sphere in which they may be usefully employed is wide, comprising general testing, small light and power plants, battery charging panels, ignition systems, battery testing and electric vehicles.

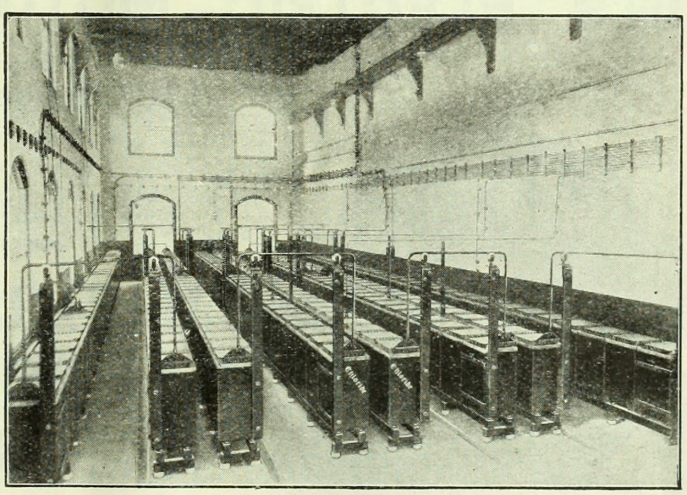
They are small enough to be conveniently carried in the pocket or to be held in the hand, and their weight ranges from 11 ozs. to 1 lb.

Write for full particulars.

WESTON ELECTRICAL INSTRUMENT CO., Ltd.,
Audrey House, Ely Place, Holborn, London, E.C.1.

Telephone: Holborn 2029.
Telegrams: "Pivoted, Smith, London."

264 C.H.W. 7 Chloride Cells.



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The above battery was recently installed at

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THE Chloride ELECTRICAL STORAGE COMPANY LIMITED.

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USE EXIDE BATTERIES FOR CAR STARTING AND WIRELESS.

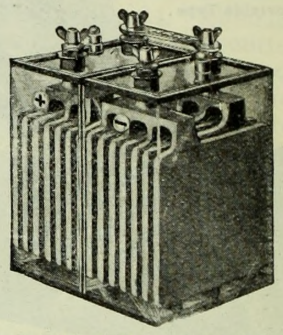
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BRITTAIN'S ELECTRIC MOTOR Co.

(Formerly Langdon-Davies Motor Co.)

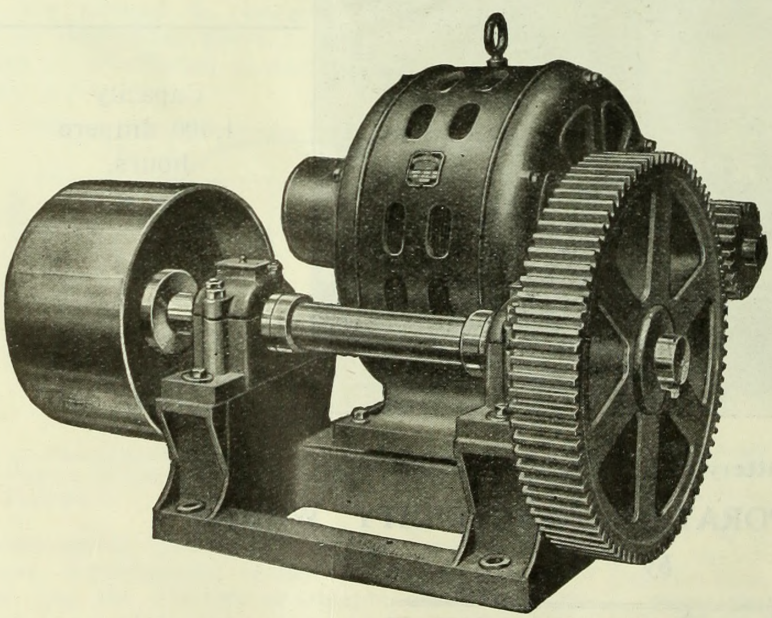


Illustration shows a 40 B.H.P. Standard Back-gear Motor.

NOTE the Robust design maintained throughout.

110, Cannon St., London, E.C.

Telegrams: "Damophon, London."
Telephone: City 2744, 2745.

***Works*: LEWISHAM, LONDON, S.E.**
Telephone: Lee Green 1473.

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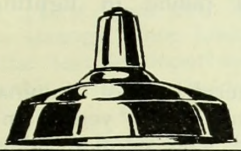
YOUR ENQUIRIES WILL BE PROMPTLY DEALT WITH.

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Don't worry! THERE IS A BENJAMIN REFLECTOR for EVERY CLASS of LIGHTING INSTALLATION.



Advt. of the Benjamin Electric Ltd., Brantwood Works, Tariff Rd., N.7

TO OUR READERS.

ELECTRICITY is published every Friday, and, if ordered, is on sale at the principal Railway Station Bookstalls and Newsagents on that day. It has a very large sale throughout the United Kingdom, as well as in the British Colonies and Abroad.

New advertisements for the displayed columns and alterations to existing ones must reach the publishing office not later than first post Tuesday morning, in order to be in time for the issue of the following Friday. This is important. Rate quoted on application. Subscription : 13s. a year, 6s. 6d. half-year, 3s. 3d. a quarter in advance, postage prepaid in the United Kingdom and abroad.

Questions to which an answer is required must be accompanied by a 1½d. stamp for reply. When considered of sufficient interest, the answer will probably appear in the paper.

All remittances payable to the Publishers, S. RENTELL AND CO., LTD., 36-39, Maiden Lane, London W.C. 2. Telephone No. 2460 Gerrard.

Current Topics.

1924.

On behalf of the proprietors of ELECTRICITY I do most heartily wish my very numerous readers the best of health and prosperity in the coming year. I admit quite frankly that I am an optimist, and I think that, apart from any question of politics, the electrical industry is in for more prosperous times. At any rate, it is up to us all to work hard with that end in view, and we have the further incentive of the great exhibition at Wembley, when we must show the world that there is life in the old dog yet; and the result is certain to be an enormous influx of orders which should go far towards killing the bane of unemployment. Therefore, let us say, " Here's luck," and may harmony prevail between all of us.

Wembley.

Now that the Festive Season is once more on the wane, the next event of electrical importance is the forthcoming British Empire Exhibition, which it is difficult to realise is only a brief three months ahead. From the latest reports it would appear that a fully representative display of the Empire's electrical resources and applications is being organised, and that the vast Palace of Engineering will house, *inter alia*, striking exhibits showing the extent to which electrical energy has permeated not only our homes, but our industries and commerce. All the latest and most novel applications of " juice " will be thoroughly displayed, including up-to-date telegraphy and telephony, both wire and wireless. In this connection one of the most interesting exhibits will be a representative Strowger Automatic Director Telephone Equipment as designed for the ultimate telephoning of Greater London without the aid of human operators.

Visitors to the Exhibition will have an opportunity of viewing this marvellous electro-mechanism in actual operation, for there will be two separate and independent exhibits, one on the stand of the British Post Office, the other displayed by the British makers of the apparatus, who are now executing an initial contract for 50,000 lines for London. Many overseas visitors will already be familiar with the wonderful Strowger Automatic Telephone, which, curiously enough, has hitherto developed to a greater extent in the Colonies and abroad than in the British Isles, the latest city to acquire a comprehensive Strowger system being Bombay, where two exchanges are now under construction to serve upwards of 11,000 subscribers. Another automatic telephone system, applicable to smaller capacities, viz., the Relay Automatic Telephone system, will also be on view as described in our issue of December 14, where it was erroneously described as the only one applicable to shipboard service. As a matter of fact, the Strowger system is generally applicable, and in actual service in exchanges of all capacities, public and private, from five lines upwards, including several steamship installations which have been in regular service for some years past, whilst a Strowger Automatic Telephone installation, destined for the ill-fated s.s. *Britannic*, was actually ready for fitting when war broke out.

The Aerial Ramp.

In my notes a week or so back I referred to the profiteering landlord and opportunist who saw in the new broadcasting boom another excuse for battening upon his unfortunate tenants. Among the latest authorities to take advantage of this golden opportunity is the Liverpool Corporation, who are charging one shilling per annum " as a rent and acknowledgement for the privilege," as the Town Clerk phrases it in a letter to applicants. Further, the same official points out that all apparatus is to be placed in positions to the satisfaction of the Director of Housing, and that applicants are to be responsible for the payment of all rates, taxes and assessments payable in respect of such poles, attachments and apparatus, and to keep the Corporation indemnified against all damage and claims. " Why should a tenant be able to erect a motor-shed and make a path to it without being charged, whereas we are forced to pay for putting up a couple of poles? " said an aggrived tenant. Why, indeed? The action taken savours of Socialism, yet, curiously enough, Liverpool municipal affairs are mainly controlled by a Conservative majority in the Council. Can any reader explain the anomaly?

In Ashton-under-Lyne the Property Owners' Association has decided to withhold consent to the erection of wireless apparatus unless the tenant agrees to take out an insurance policy costing 7s. 6d. per annum against damage and third-party risks. This clause is to be inserted in the new rent books. The secretary of the local Tenants' Association has advised tenants not to take out insurance policies as suggested, and states that the landlords' demand is unjustified. And so say all of of us. Why a property owner, who is in the position of a dictator, should be allowed to take advantage of the growing popularity of broadcasting further to mulct his tenants in whatever paltry charges the occasion suggests, passes my comprehension. If there were any likelihood of serious damage or risk resulting from the

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erection of the very light attachments necessary to support the average wireless aerial, it speaks volumes for the jerry character of the main structure, and possibly this is what is really disturbing the peace of mind of the profiteering landlords.

Post Office Enterprise.

Whether it be due to the beneficent influence of H.M. Postmaster-General, Sir Laming Worthington-Evans, or to some other unknown influence, the Post Office is at long last exhibiting a very refreshing spirit of enterprise which is in striking contrast to its past traditions, and, therefore, all the more commendable. Only last week I listened, per wireless, to a very well delivered address by one of the Department's leading officials on the Christmas business of this important Department of the State, and learned how essential it was to post the Season's greetings and parcels in good time if they were to reach their respective destinations in time for the actual day of rejoicing. This was indeed a happy thought, and calculated not only to secure timely delivery of the tremendous Christmas mails, but also to relieve the hard-worked staffs of the various Post Offices in time for them to reach home and participate in the festival.

My second surprise packet arrived in the shape of a neat folded postal card, dropped through the letter-box and endorsed O.H.M.S. On inspection it turned out to be a courteously worded exhortation to install the telephone for either my home or business premises, and gave particulars of the telephone rates for the district. So far as I am aware this is the very first occasion upon which the Post Office has conducted a house to house canvass on behalf of its telephone service. It is a healthy sign of the times and marks a complete reversal of the former policy of if you want a telephone you must " wait and see."

With the advent of Strowger Automatic Telephones in London and other provincial centres which do not at present enjoy an up-to-date service, the response to this individual appeal will undoubtedly prove more gratifying to its sponsors than at present when the service in many towns still leaves much to be desired. The telephone operators do their best under trying circumstances and with obsolete and inefficient switchboards and equipment, which are undoubtedly responsible for many of the complaints one hears levelled at the telephone service. On a particular line that I am in the habit of using frequently, I invariably get disconnected in the middle of eight calls out of ten. I have remonstrated with the operator, with the supervisor and with the district manager, and the only excuse they are able to put up to me is that they are still burdened with an ancient and worn-out switchboard in that particular exchange. Perhaps it is down early in the list for conversion to automatics; at all events I hope so.

Illuminating Engineering in Practice.

How best to bring home the importance of good lighting to the consumer? This formed the keynote of the address by Messrs. G. Herbert and R. A. Ives before the Illuminating Engineering Society, on December 11. All agreed that the non-technical public must be reached by aid of simple explanations, and by pointing to practical benefits of good lighting. The chief difficulty has been that we have not yet sufficient authentic data illustrating actual effects of improved lighing in preventing accidents, diminishing spoiled work, etc. Obviously information of this kind, in order to carry weight, must bear the hall mark of a recognised authority, and some of the work now being done by the Society in this direction should yield "ammunition" of great value to those approaching the general public in lighting matters.

Standards of Illumination.

There is no doubt that the general level of illumination has greatly advanced during recent years, and there are some who predict values much in excess even of those in use to-day. I fancy, however, that the public, if told that they are to use, say, five or ten times as much light as at present, will require some justification. It is here that the "ammunition" comes in. Propagandists will find their task lightened considerably if they are able to quote impartial tests, preferably made with the assistance of bodies representative of the industries concerned giving actual chapter and verse.

ELEKTRON.

STORAGE BATTERIES.

At the November meeting of the Birmingham and District Electric Club there was a lecture on storage batteries by Mr. E. C. McKinnon, A.M.I.E.E. The lecturer gave an interesting account of the evolution of the design of modern storage batteries, with the numerous variations called into existence by their many uses, ranging from the small accumulator for a motor-cycle to the great storage battery of a super-power station, each one having its special and peculiar requirements. Much valuable information was given in connection with the care of batteries in actual use. It was shown that the many diseases from which they appear to suffer are caused by ignorance or negligence on the part of the attendant; seldom, if ever, by faulty design. The lecturer did his best to remove the first cause of trouble; the idleness and carelessness of attendants, unfortunately, being beyond his influence.

Plant Wanted.—The Municipal Council of Johannesburg invite tenders for 240 steel tram poles, dach complete with finial and centre clamp; five miles of 0000 s.w.g. (.4 in. diameter) round section hard drawn copper trolley wire with a conductivity of not less than 98 per cent. Mathieson's standard Particulars from the D.O.T., 35, Old Queen St., London, S.W.1.

Calendars.—From the Hart Accumulator Co., Ltd., we have as usual to acknowledge the receipt of their always useful blotting pad. It is also accompanied by a monthly wall calendar, and most certainly anyone who is favoured with one cannot complain of its legibility, as the size is such that it can be seen easily from any part of an accumulator room or office in which it may be fixed. For this reason it should prove eminently useful.

The C.P. Engineering School.—Mr. A. W. Szlumper, C.B.E., chief engineer of the Southern Railway, presided on Wednesday, December 19th, at the distribution of certificates to the Crystal Palace School of Practical Engineering, and addressed the students. He spoke of the grouping of the railways as destined to bring about efficiency and economic working. Everything would be standardised among the railway groups, and by this means there would be a considerable reduction in cost of maintenance.

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MR. BOUNCER MEETS MR. STAN DARD.

By George E. Moore.

The Ineffable Mr. Bouncer.

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(*Concluded from page 680.*)

[Last week saw Mr. Bouncer starting his career in a strange place known as the "Rest House"—really the testing department of an electric supply undertaking. Here, holding sway over the "Instrumental Section" (including two harassed assistants), reigns an irrepressible gentleman called Mr. Stan Dard. This week Mr. Bouncer has the misfortune to fall foul of the latter.]

Into the Lion's Den.

Returning to Mr. Bouncer, we find that he has been passed into the metering section. This being his first introduction to meters he concluded that, though they were nothing much to worry about, yet he might as well spend a couple of minutes or so getting the hang of them. After he had wandered around, much after the fashion of a visitor to the National Gallery, he was approached by a harassed-looking individual who appealed to him to lend a hand on a meter test. Mr. Bouncer unbent so far as to undertake to time the disc revolutions with a stop-watch, while the other directed a mournful look upon a battered wattmeter. Mr. Bouncer gave a sudden laugh, completely spoiling the start-off. "Why," he said, "this stop-watch is no *earthly* good. It won't go." "Oh, murder!" said the watts observer. "Is that watch potty again? I'll tell you what: just go along to Mr. Dard and get the loan of his standard stop-watch."

Mr. Bouncer gave a curt nod and leisurely made his way across the frontier to Mr. Dard's headquarters, entirely unconscious of the suspicious glances shot at him by the outposts.

He arrived at a most inopportune moment, for Mr. Stan Dard, as was shown by the disposition of his eyebrows and the black velour hat, was wrestling with a Problem. It was a gigantic Problem, and Mr. Stan Dard had settled down thoroughly to enjoy himself. The Problem was this: A power-factor meter had just been used, but its indication had been doubted. Upon checking it (and re-checking it) and at last taking a final check, the power-factor meter was found to be reading correctly. This should not have been so, for, after applying five corrections, it should have read .01 per cent. high. Now this was very baffling, and it really looked as though there should be a sixth correction somewhere. But where? Small wonder that Mr. Bouncer's arrival was ill-timed.

Mr. Bouncer edged up to the desk and waited, for Mr. Dard's utterly blank gaze showed that he was quite oblivious of him. Mr. Bouncer did not mind waiting, for surrounding the innocent-looking power-factor meter was a provoking display of weird "curves" and gadgets. After a few minutes Mr. Stan Dard began to show some signs of restlessness, for it was impossible for his thoughts to function in the upper reaches of logic with that foreign object standing there by his desk. His blank gaze changed into a scowl so forbidding that Mr. Bouncer thought his tie was crooked, so furtively adjusted it on the zero line of his shirt and inched away a little. His boots gave a tremendous squeak, and at last Mr. Dard abruptly came to earth. Away went the black velour hat in a great hurry.

"What the devil do you want?" demanded Mr. Dard, testily.

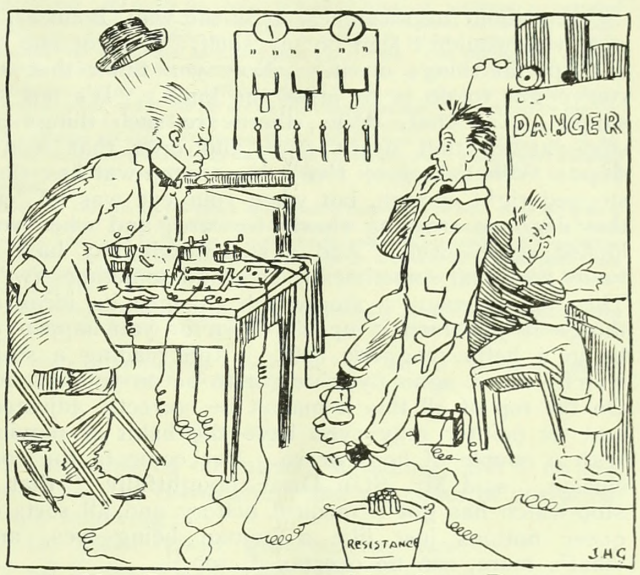
This seemed such a vulgar opening to a technical conference that Mr. Bouncer was naturally flabbergasted. He was bereft of speech—a sure sign of his astonishment.

"Hey?" said Mr. Stan Dard.

Mr. Bouncer pulled himself together. "Oh—er—I've called, Mr. Dard, for the standard stop-watch."

Mr. Dard made a sudden jump and retrieved his hat. "Standard stop-watch," he muttered dazedly. "He wants our standard stop-watch," said he to the hat. Then, to the intruder: "What on earth for?"

"Well," replied Mr. Bouncer patiently, "I have been asked to measure the time taken for the moving element of an integrating watt-hour meter to rotate a prescribed number of times." (This made Mr. Dard sit back and clutch his hat). "Accordingly," went on Mr. Bouncer, warming up, "I had recourse to the stop-watch allocated to the metering section, but I discovered that this intermediary was entirely ineffective, and—er—(Mr. Dard's gaze was a bit disconcerting)—well—the beastly thing's no good."



Mr. Bouncer meets Mr. Stan Dard.

The black velour hat fell off. "No good?" rapped out Mr. Dard. "Pooh! Bosh! Impossible!" Then, with a sigh, "Let's see it. Have you, by the way, tried winding it, Bouncer—you *are* Bouncer, I believe?"

"Of course, I have—am," replied that gentleman, feeling somewhat nettled and not troubling to conceal his disdain.

Shown-up!

"You have, have you? Hm! Why, so he has. Hello! It's not going, Bouncer. This is the kind that goes all the time, and where you sort of clutch-in the flyback business. My *dear* Bouncer!"

Mr. Bouncer was somewhat staggered by this news. "Oh, well," he said, "of course if it's *that* kind." He reached for the stop-watch.

"Half a jiffy," said Mr. Dard. "I'm not so sure

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that you ought to have this watch, let alone my standard one. Do you know anything about stop-watches, Bouncer?"

"Know anything?" repeated the other. "I should think I do. There's nothing to know, anyway."

"Oh, indeed," observed Mr. Dard. "I suppose you think all you've got to do is to press the knob. Hey? Don't you run away with that idea. Mind, you're not the first bright young fellow we've had here who's done that. Oh dear no! There's more in a stop-watch than meets the eye, I can tell you. Why," said Mr. Stan Dard in a most impressive tone, "it's the measurement of time—the measurement of time. *I've* been up against it. So's Einstein. And a stop-watch is just the very thing to make you stop and think. We once had a young fellow here who got so vexed with stop-watch troubles that he set out to make an electric chronoscope that'd whack the stop-watch hollow. I believe it worked all right (he said so, anyway), but as we haven't got waistcoat pockets the size of 50-lb. sacks we heard no more about it. I remember that young fellow well," said Mr. Dard, putting on his hat and looking reflective. "Although he bothered a lot about measuring time, he never seemed very punctual, and many's the morning I've seen him slip in the back way to dodge the Chief.

"But about stop-watches. (By the way, Bouncer, I wish you wouldn't lean on my shelf. It's got one or two special things on it.) Now *you* think that all you've got to do is to press the knob. It's not so simple as all that. Why, there are such things as stop-watches that won't start and ones that won't stop. What's more, I've known stop-watches that stopped right enough, but when your eye was off 'em they'd go on creeping slowly forward, and when you looked again—well! And a stop-watch may have a funny zero that sometimes *is* zero and sometimes *isn't*. Then again, many a stop-watch changes its ideas of things if you turn it upside down or you happen to be in a hefty magnetic field. And reading a stop-watch—there, again, you've got to be on your guard. On the top of all this it mayn't be correctly adjusted, and its pointer may even have the habit of moving with a couple of hops or so. I've come to the conclusion," said Mr. Stan Dard thoughtfully, "that a stop-watch has got a medical history and all sorts of queer notions just like a human being—yes, and what's more, can be overtaxed, too."

This brilliant observation, with its subtle political flavour, so captivated Mr. Dard that he became plunged in meditation. Mr. Bouncer, now somewhat bored, not to say crestfallen, picked up the stop-watch and tip-toed out. His protesting boots woke up Mr. Stan Dard, who jumped to his door and quite upset the nerves of his sleepy assistants outside. "Oh, and Bouncer," Mr. Dard called out in a distressingly loud voice, "just you let the clockmaker show you the inside of that stop-watch. It'll do you good. And any time you want any advice just drop in."

Mr. Bouncer responded by a distant nod, and then, to the great relief of everybody, Mr. Stan Dard vanished. A few seconds later he was once more in the throes of the Problem, with a fixed glower on his face for the unfortunate power-factor meter, whilst the black velour hat reposed peacefully in the waste-paper basket. And outside the pill-box we had better take our farewell of Mr. Bouncer. There he is likely to be detained some time, for the clockmaker, hearing Mr. Dard's parting injunction, has leaped into the fray and is rapidly submerging our friend in an eloquent oration ranging from time-switches to grandfather clocks.

SOME HOWLERS.

It is always a pleasure to read the Crystal Palace Engineering School Magazine, and to watch the progress of Mr. Wilson's old pupils in all parts of the world. Speaking figuratively and truthfully they turn up everywhere, from China to Peru, and worthily maintain the reputation of the school for turning out men who will be a credit to the British engineering profession. It is also interesting to read some of the answers inserted in their note books by junior students, and those which we insert below are certainly calculated to raise a smile on the faces of most of our readers. Yet some of the authors of these howlers may, in the long run, rise to positions of great importance and laugh heartily over their early mistakes. One never knows:

The thickness of the shell of a boiler = 420 inches.

Boring means to turn the outside into the inside.

Centrifugal force of a 14-stone passenger round a railway curve = 144,144,000 lb.

The number of wagons to cart 6,600 c. yds. of clay = 2.

The pressure on the square inch in a pump = 160,871,981 lb.

A cross staff is a thing you put on a pole to see if the thing is straight.

The time taken to bore a cylinder = 377.67 hours.

The number of $\frac{5}{8}$ in. spherical bullets in a cwt. of lead = .02.

The cost of painting a drawing office table = £174.

The superstructure of a bridge is always put up by divers.

Under most circumstances it is possible to measure up to and from any point, however inaccessible.

Our bodies consist of the following parts:—$\frac{3}{4}$ oxygen, 4/5 plants, $\frac{1}{2}$ rocks, 8/9 water.

Power required for repulsion increases the speed of the cube.

The number of bricks required to build a wall 120 feet long and 28 feet high = 46.

The number of revolutions per minute of a screw propeller = 645,382.

The tensile strength of a $1\frac{1}{2}$ in. diameter wire rope = 18,120 tons.

"Crossley Productions" is the title of a very well illustrated booklet which has just recently been issued by **Crossley Bros., Ltd.**, of Openshaw, Manchester. It gives illustrations of the well-known gas, oil, petrol and other types of engines with which the name of Crossley has been identified for nearly sixty years, as well as of their suction gas plant and the Crossley cars, agricultural tractors, motor road rollers, light locomotives, and similar machines. They have also sent an attractive monthly wall calendar, which is certain to be appreciated by all their clients.

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A NEW TERMINAL.

Another one of "those little things that tell" has been introduced by Messrs. Gent and Co., Ltd., of Faraday Works, Leicester, in the shape of a new terminal that will appeal to all our readers.

All ordinary terminals designed to grip the conductor between flat or plain surfaces have the tendency in practice to throw out the wire that is being clamped. To insure a good contact, and to avoid this inclination to throw out, it is general practice to bend the conductor into a loop or hook or hair-pin bend, so as to embrace the terminal screw; and even then, especially when the clamping surfaces of the terminal are small compared with the conductor, the tendency is, when clamping up, for the bend to open and the wire to be forced out.

FIG. 1.



With the "Crescent" terminal the tendency is to force the conductor further in and nearer to the central screw the more the clamping surfaces are forced together by tightening. In it the under side of the usual milled nut is made dome-shaped instead of flat, and the dome is arranged to descend into a channel of the same radius formed in the body of the terminal. One has only to hold two coins together and move one over the surface of the other, watching the outside edges of the coins, to observe how the gripping surfaces of the "Crescent" terminal close their outer edges first, and so prevent the wire escaping. This point is also appreciated by studying the black diagram (Fig. 1) marked "Crescent."

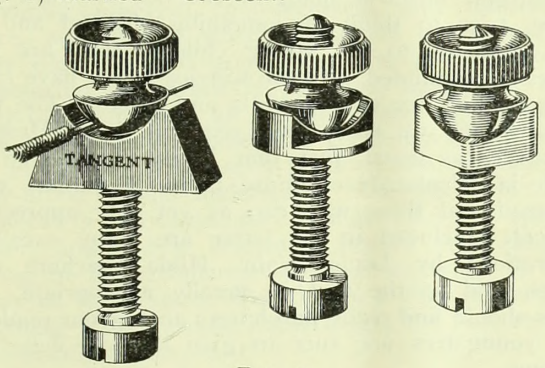


FIG. 2.

So sure is the "in-thrust" that it is not necessary to loop the wire to be held; a straight wire, as shown in Fig. 2, being clamped electrically and mechanically secure with ordinary thumb-and-finger twist. Pliers are never necessary. Several terminals with protuberances on the bottom plate, to prevent the conductor being thrown out, are in existence; but the "Crescent" has a further advantage that, however fine the wire is to be clamped, the tendency is still to force it inwards, and whether the wire is small or as large as the terminal will take, a permanent contact is insured by twisting with the finger and thumb only.

For railway and motor work, where vibration is ever present, for fire alarm circuits, electric clock circuits, and all connections where a permanently secure contact is paramount, this new terminal will appeal to the electrical engineer; while in apparatus where quick connections are to be made and altered, it will be found to be of extraordinary value, particularly as the wire can be kept straight and need not be bent before clamping.

Amongst others, the "Crescent" terminal has the following advantages:—

(1) It will grip fine wires even up to 40 s.w.g. It will also grip a straight wire or bar of metal. It will grip flexible securely without crushing, or a stranded cable up to any diameter that will enter the paws of the terminal.

(2) It is not loosened by the vibration experienced on railways, ships and motors, or by the small and insistent vibration in factories and works. It will not throw out the wire that is being clamped, whether straight or hooked.

(3) Secure contact is insured by finger and thumb pressure only. Pliers are not necessary. If the terminal is tested by clamping a human hair, a telephone tag or an electric light cable, its virtues will be appreciated.

Questions and Answers by Practical Men.

RULES.

QUESTIONS: *We invite our readers to send us questions, preferably on technical problems that have arisen in actual practice. Questions which we consider of sufficient interest to our readers will either be replied to under "Answers to Correspondents" or replies will be invited from our readers. One shilling will be paid for the question which we select for competitive replies in this column.*

ANSWERS: *A fee of 10s. will be paid for the answer which we consider shows the greatest merit, and 5s. for the one we select as second best. In judging the replies importance will be attached to clearness and conciseness, as well as accuracy. The Editor reserves the right to make no award, or to accept only one reply, if, in his opinion, the answers received do not possess sufficient merit. Competitors desiring the return of their manuscripts, if unaccepted, should enclose stamped addressed envelope.*

Write on one side of the paper only, and if diagrams are sent, draw them on a separate sheet of paper attached to the manuscript. Competitors may adopt a "nom de plume," but, both in the case of questions and answers, the competitor's real name and address must be sent with the manuscript as a guarantee of good faith. No correspondence will be entered into with regard to successful replies. The Editor's decision is final.

Commencing with Question No. 101, a Diploma of Merit will be awarded to the six competitors who win the first or second prize the most times during the next twelve months.

The words "Questions and Answers" or "Q" and "A" should be placed at the top left-hand corner of all letters intended for this column.

QUESTION NO. 173.

I am employed on railway signalling, and I do not understand the construction and principles of operation of the following:—

(1) Track relays, galvanometer type.
(2) Track relays, vane type.
(3) Detection relays, polarised vane type.
(4) Purpose of shading bands on latter.

I would appreciate the details of operation, etc. The tracks are single-phase, 25 to 33½ cycles.—"JACK ALLEN."

QUESTION NO. 174.

Can any reader inform me of the process by which accumulators are treated to enable them to be put on the market in what is known as "a dry and fully charged condition," i.e., only requiring to be filled with dilute acid and to be given a short freshening charge?—"C. R. HARDY."

(*Replies to Questions Nos. 173 and 174 must be received not later than January 5, 1924.*)

Answers to Questions.

QUESTION NO. 169.

I wish to make a resistance to reduce a pressure of 200 volts to 25 volts. I would appreciate details of size

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of wire, method of mounting coils, etc. The maximum current I wish to take from it is 15 amperes.—J. R. WOODHATCH.

REPLIES TO QUESTION No. 169.

The first prize (10s.) has been awarded to "L. R." for the following reply:—

In connection with the design of electrical resistances, this turns on the particular use to which they are to be put, because the permissible temperature rise is one of the features governed thereby, the time at which the resistance will be used at full load, and the number of steps essential to bring the resistance to the full also being governing factors.

In the case of a resistance to be applied to a 200-volt circuit for the purpose of reducing the voltage to 25 volts, and adapted at full load to carry 15 amperes, a considerable loss of power is incurred, and it is, to say the least, questionable whether this is the more profitable way to proceed to obtain the desired effect or not.

Whatever form of resistance be employed, whether it be wire, water or any other type, the loss in the resistance is proportional to the product of the square of the current and the resistance, or to the product of the current and the voltage drop. The voltage drop in the case under consideration is 200 minus 25 equals 175 volts. The full load current is 15 amperes. The watts lost are, therefore, 2,625, that is, somewhat over 2½ kilowatts. Assuming, however, such a resistance be necessary, the following will show how it may be designed.

Resistance is equal to the voltage divided by the current, that is, 175 divided by 15 equals, approximately, 11.6 ohms, taking the full load current into consideration.

It will be better to employ one of the modern high-grade resistance materials than to use iron wire, because with such a large resistance for a comparatively heavy current, the amount of iron wire required will be high.

Taking, as an example, nickel chrome wire, S.W.G. No. 10 carried 16 amperes for an approximate temperature rise of 100 deg. C. Assume this temperature rise to be permissible, then this wire may reasonably be used. No. 10 S.W.G. nickel chrome has a resistance of 103 ohms per 1,000 yards at 15 deg. C., and 108 ohms per 1,000 yards at 100 deg. C., that is to say, approximately 1 ohm per 10 yards. 11.6 ohms will require 112 yards on the basis of the starting temperature of 15 deg. C. The weight of this wire is 151 lb. per 1,000 yards, so that the weight for 112 yards is almost exactly 17 lb

In order to mount such a wire, in all probability the most convenient way is to obtain an old resistance frame and to space it thereon, connecting points to the stops at suitable intervals. Connection at equal intervals will not yield a gradual increase of resistance, but spacing should be so carried out as to provide substantially equal increments of current from one stop to the other. It is really the change in the current value as the resistance arm moves from stop to stop that determines the effect of the resistance.

The resistance designed above gives the required voltage drop at full load. On the other hand, this will not be obtained at lower loads, and the value of the resistance that will have to be employed depends on the amount of current which it is permitted to pass at each stop. This again requires it to be known what is the resistance of the apparatus to be used in series with the resistance

Assume that it is something which takes 15 amperes at 25 volts and, therefore, has a resistance of 25 divided by 15 equals 1.7 ohms; the following table will show the total amount of resistance required, and the additional amount to be provided if the first stop of the resistance has to pass a current as specified, namely, from 1 to 15 amperes, the table also indicating, on the assumption that one ampere is the current for the first stop, the spacing of the points for other stops to pass the currents specified:—

Main voltage.	Current.	Total Resistance.	Added resistance, that is, total current less 1.7.
200	1	200	198.3
200	5	40	38.3
200	10	20	18.3
200	15	13.3	11.6

"L. R."

[*The answers of the second prize winners (two, 5s. each) will be published in due course.*]

Reviews of Books, &c.

[*Books noticed in this column will be sent from* ELECTRICITY *Office to any part of the world, for the published price, plus five per cent. for postage (minimum 2d.), and orders will be appreciated.*]

FATHER TUCK'S ANNUAL (5s. net); LITTLE PEOPLE'S ANNUAL (4s. net); (Raphael Tuck and Sons, Ltd.).—Once again we have come to the time when even the hard-hit business man, or the out of work employee, tries to think of something cheerful and to give happiness to the young children who are not yet really acquainted with the worries which have such bitter realities for their parents and elders. The two books which we have just received from Messrs. Tuck are, as usual, just that happy class of work which is calculated to amuse both the juniors who can read and those who can as yet only appreciate pictures. Included in the latter are many excellent illustrations by Louis Wain, Hilda Cowham and others, and as the text is equally appropriate, the books should find ready purchasers among our readers. The youngsters are sure to give them a delighted welcome.

B.E.S.A. LIST OF TERMS AND DEFINITIONS USED IN RADIO COMMUNICATION.—This list, No. 166, 1923, forms one section of a vocabulary of terms and definitions used in electrical engineering which is in active preparation by the British Engineering Standards Association, and will be issued shortly.

The present list of radio terms and definitions contains definitions of about 170 terms in general use, but owing to the rapid growth of the subject it is not possible to include every term used in connection with radio science, and such new terms as survive will be incorporated in future revisions of the list. Where the same definition applies to more than one term, the term recommended for general use is printed in bold

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type, the other terms being given in lighter type as synonyms of the preferred term. In this way the committeee responsible for drawing up the list hope to encourage uniformity in the matter of nomenclature, a step which is specially desirable in the case of such a rapidly developing science as radio communication.

Copies of this publication are obtainable from the B.E.S.A. Publications Department, 28, Victoria Street, London, S.W.1, price 1s. 2d. post free, and also from the office of ELECTRICITY.

Congratulations to Mr. J. Murray Allison on the December issue of 20TH CENTURY ADVERTISING. It is certainly a most valuable and instructive work for all who are in any way associated with publicity and have to control the design and placing of adverts. We are confident, therefore, that it will interest a very large number of the readers of this paper. The price is 2s. 6d. net, and the publishing offices are at Bush House, Aldwych, W.C.2.

THE BOOK OF THE FORD. 8th edition. (Temple Press, Ltd., 2s. 6d. net.)—The eighth edition of the original and popular "Book of the Ford," by Mr. R. T. Nicholson, has been entirely re-written, re-illustrated and brought right up to date. Since the seventh edition was issued, the original right-hand drive has been re-adopted on this car, and the new edition treats in the main of the latest type, but users of left-hand drive will still find the book meets their requirements, as the features of older-model Fords are dealt with in a special chapter. The mass of information given is, of course, generally applicable to any fairly recent Ford model. In re-writing this hand book the author has considerably extended the information and advice on the handling, adjustment and upkeep given in previous editions. This is of a thoroughly practical, non-technical and interesting nature, and is just what any actual or prospective owner requires. No previous mechanical knowledge or motoring experience is assumed, and there is a wealth of illustrations, all specially drawn for the book, which explain at a glance the construction, working and adjustment of all such parts of the car that an owner-driver should understand. The Ford electrical equipment is well explained and illustrated in a special chapter, and a new illustrated feature is a chapter treating of the commercial and service types of car. It may be fairly stated that this new edition contains everything a user should know to get the best results at the smallest expense.

TAIT'S ELECTRICAL DIRECTORY OF AUSTRALIA AND NEW ZEALAND. 1923 edition. (Tait's Publishing Co., Melbourne. 6s. net.)—This very useful directory is issued from the office of our esteemed contemporary, the *Commonwealth Engineer*, and maintains right worthily the reputation of that paper for careful accuracy, combined with continued enterprise. The fifth edition certainly shows signs of healthy growth, as it is considerably larger than its predecessors, and its compilers think that, so far as lies in their power, it includes every public or private undertaking which generated or distributed electrical energy in Australia and New Zealand at the time of going to press. Special features are the inclusion of the great government power stations and hydro-electric schemes, and the book should prove of direct value to every English manufacturer or exporter of electrical apparatus who wishes to enlarge his trade with these two great Colonies. At present the bulk of the generating plant is undoubtedly British, but here and there one notices American or Continental names, and it is therefore up to us to see that the percentage of such plant does not increase at our expense. The trade is there for us.

THE ELECTRICAL CONTRACTOR'S YEAR BOOK, 1923-4. (Electrical Contractors' Association. 3s., post free.)—We extend a cordial welcome to the new edition of this year book, which is, we are glad to note, increasing steadily in bulk owing, no doubt, to the continued growth in the number of members of the Association and the importance of the position which it holds in the electrical industry. This issue contains a list of the council officers for the new session, as well as of the sectional committees, and a complete list of the members generally in the various towns of Great Britain. There is also an interesting history of the Association and a list of the past presidents. The activities of the Association during the past twelve months are duly set forth, together with particulars of other kindred associations which should be of direct interest to members; also there are certain chapters on legal matters, wages, etc., with which every contractor ought to be fairly conversant. Details are given of the working agreements with the trade unions and kindred associations in the various parts of Great Britain. Altogether it is a very useful work, and should be in the possession of every electrical contractor in the country, whether a member of the Association or not. In the latter case, the sooner he becomes a member the better for him and for the industry in general.

AN IMPROVED WIRELESS SET FOR SHIPS' LIFEBOATS.

In the improved Marconi wireless sets for ships' lifeboats, which was recently demonstrated at Gravesend before the Seafarers' Joint Council, the transmitting power is about four times that which could previously be obtained, with a corresponding improvement in range of about fifty per cent. Further, the arrangement of masts and aerials is such that they can easily be handled in an open boat at sea, and the apparatus and operator are afforded adequate shelter from the weather, while the directional receiver enables the actual direction of a rescuing vessel to be determined with sufficient accuracy up to the full distance over which boat signals can be received by ships' apparatus in most common use. With an aerial as used in the standard 26-ft. open lifeboat, in which masts 22 ft. high and 24 ft. apart can be fitted, the new set can be relied upon to draw the attention of any ship at a distance of at least fifty miles over sea. This necessitates the use of a 600-metre wave and of spark telegraphy, and involves a power of nominally $\frac{1}{4}$ kw. The whole of the wireless outfit, excepting, of course, the masts and aerial, is contained in a weatherproof case of such a size that it reduces the seating accommodation by two, and its weight is equivalent to that of two "official men."

The new instrument gives the bearing of the station from the receiver, and is of the utmost value when a ship's crew has had to take to their boats, as it allows

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them to inform the rescuing ship of the direction in which she should steer in order to pick them up.

Two aerials are used in this system. One, termed an open aerial, is used both for transmission and reception, and has no directional effect, so that receiving signals will have the same strength regardless of the bearing of the distance station. The other, a frame aerial, is used for direction-finding purposes. When the frame is edgewise on to the distant transmitter the signals received will be of maximum strength, and they will gradually diminish in strength as the angle of the frame to the incoming signals is increased. They will be inaudible when the frame is broadside on to the transmitting station. By rotating the frame, therefore, the operator can ascertain the bearing of any wireless station within range of his instrument. The open aerial alone gives no idea of direction; the frame aerial alone allows the direction to be determined with accurracy, but does not discriminate between "towards" or "away from," and a combination of the two allows of the "towards" direction being distinguished from the "away from" direction.

BROADCASTING ILLUMINATING ENGINEERING.

In his "talk" broadcasted on December 19, which was doubtless heard by many of our readers, Mr. Gaster dealt with primary principles of good lighting in the home, school and office. A telling illustration of the effects of undue contrast was provided in his remark that one sees the lighted stage of a theatre with ease, but can seen nothing when looking from a brightly lighted room into the dark street outside. He also advised consumers to keep their lamps and fittings clean, and to discard old lamps as soon as the bulbs have become blackened or the light is greatly diminished. Simple hints on the lighting of drawing and dining rooms, kitchens, schools, offices and shops were included, and there was a final reference to the work of the Illuminating Engineering Society. The British Broadcasting Co. have done good service by allowing their far-reaching medium of publicity to be used for the dissemination of information on illumination. No doubt, in his second talk, in March next, which, we understand, will deal mainly with the lighting of streets and factories, Mr. Gaster will have more good advice to offer.

Personal.—Professor M. Chatelain, the President of the Central Electrotechnical Council in Russia, President of the Russian I.E.C. Committee and President of the recently-formed Russian Engineering Standards Committee, has spent a few days in London meeting influential people in the electrical world, and before his departure for Petrograd he was entertained at lunch at the R.A.C. by the B.E.S.A.

Peru.—A report on the trade of Peru to August, 1923, has just been issued by the Dept. of Overseas Trade, and may be obtained from H.M. Stationery Office or ELECTRICITY Office at 1s. 2d., post free. On page 10 there is an interesting paragraph dealing with foreign competition, in which it shows that Germany is likely to do an increasing trade in electrical appliances, and that it is up to British firms to meet the competition to the best of their ability.——Another similar report, price 1s. 2d. net, post free, deals with the trade of Cuba, in which it states that owing to the considerable growth in the purchase of sugar by Great Britain from Cuba, there is likely to be an increased demand for British goods, which should be most cordially cultivated by merchants and manufacturers on this side.

C.T.S. COMPETITION—EXTENSION OF TIME.

Our attention has been drawn to the fact that while in some cases the intervention of the Christmas holidays will afford some competitors a quiet time during which to write or prepare a carefully reasoned paper to send in, yet with others it may be the reverse, and the St. Helens Cable Co. have therefore decided to extend the date for receiving papers from English competitors to the last post on Thursday, January 31, 1924. Will our readers please note this. The remaining conditions remain unaltered.

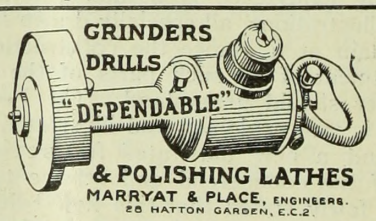
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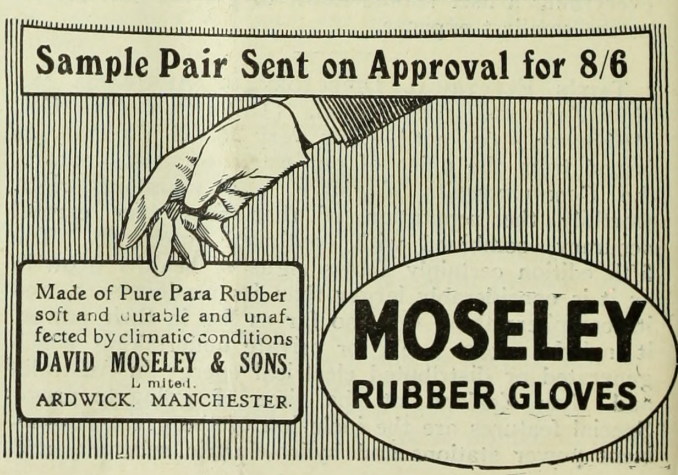
"Saving 70 per cent." is the title of a neat pamphlet which has just been issued by the **D. P. Battery Co., Ltd.**, of Bakewell, Derbyshire, and sets forth in brief, but clear, terms the advantages of the latest types of D.P. short firstcharge batteries. It will interest all users of accumulators and installation engineers generally.

We have recently received from **Messrs. Wm. Sanders and Co.**, of Wednesbury, their latest attractive 40-page catalogue of "Superior" Ironclad switch and fuse gear. For the reader's convenience it is divided into sections, ranging from large unit type lighting and distribution boards down to such small items as cable glands. Many of the items have been entirely redesigned and numerous improvements made, while the mica-metal principle of insulation has been substituted for slates and such-like compositions.

A catalogue of electrical accessories has just been issued by **Messrs. Reeves and Co.**, of Crescent Works, Birmingham. Judging from a careful perusal of the list, it does most certainly seem that a serious attempt has been made by Messrs. Reeves to meet foreign competition in their particular line of goods, all of which are absolutely English in every component part, while it is claimed that quality has been maintained at the highest point. The list should prove of value to installation contractors generally, who are advised to write for it without delay.

Lists to hand from the **Sun Electrical Co.**, of 120, Charing Cross Road, London, deal with Sunlite reflectors and A.B.C. washers and wringers of various types, in all of which there should be good business for the enterprising contractor and retail dealer in electrical supplies. We recommend application for copies—on trade paper, of course.





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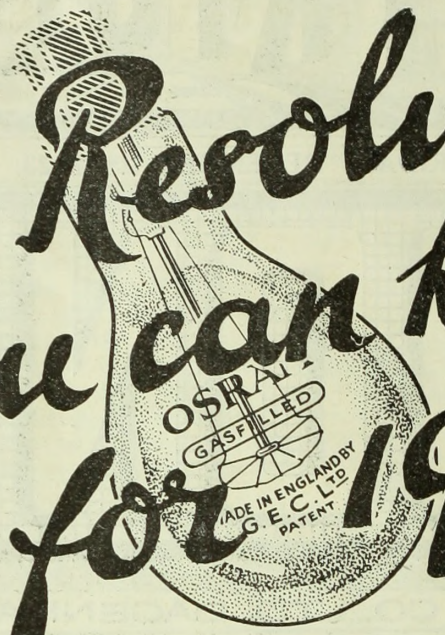
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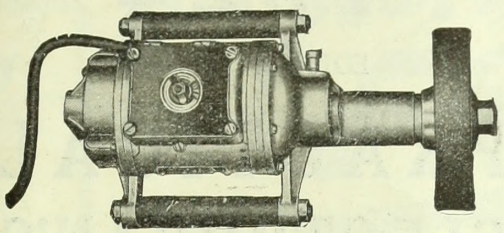
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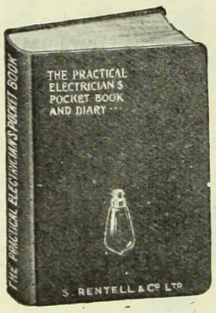
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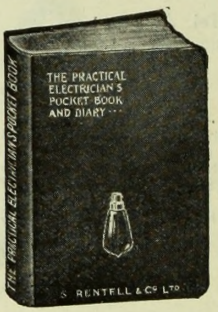


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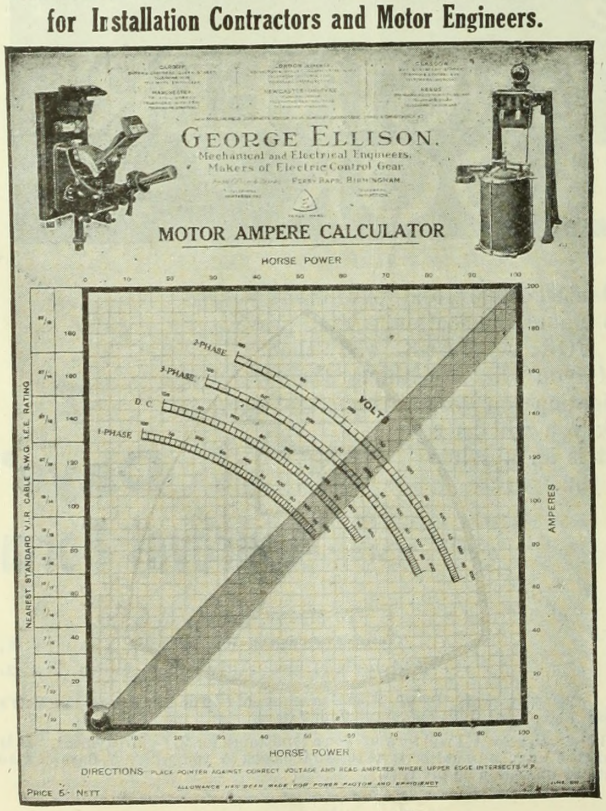
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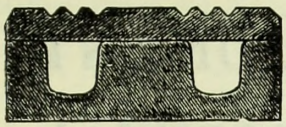
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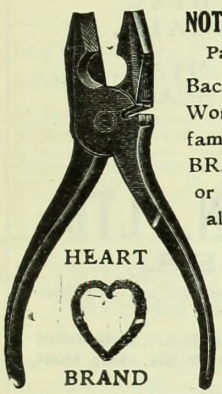
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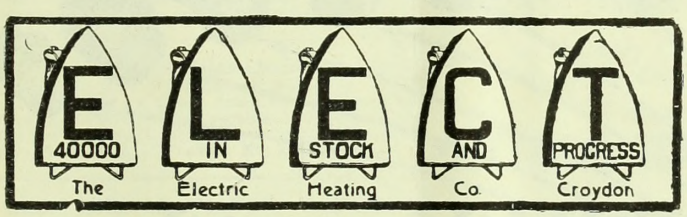
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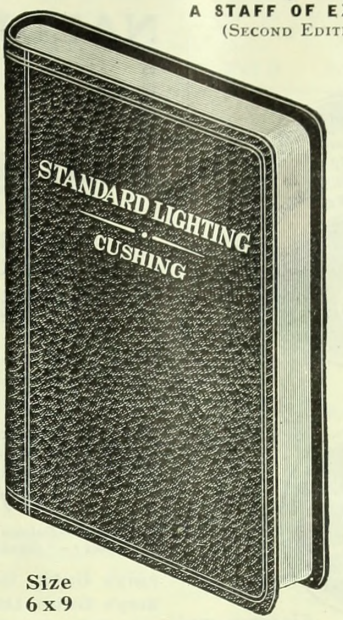
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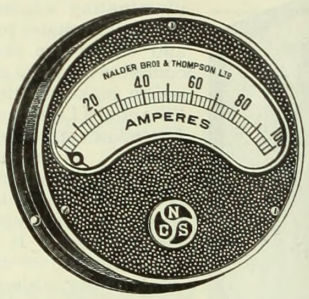
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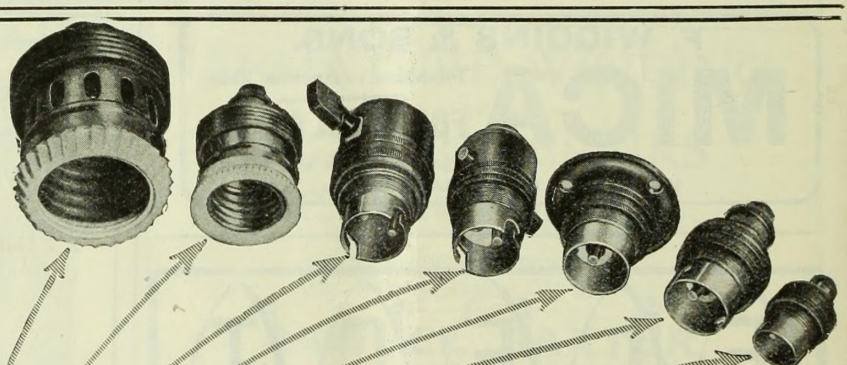
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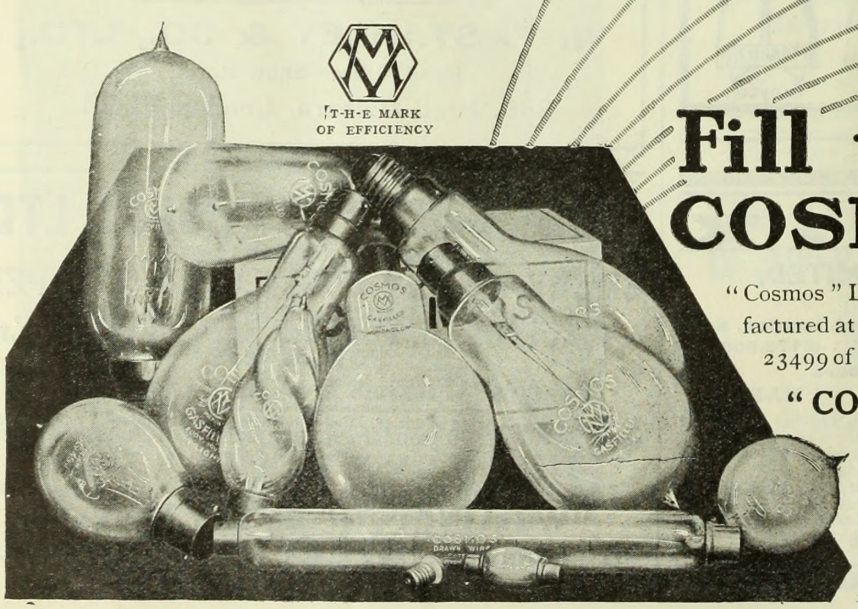
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